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Resistance of a Single-cross Hybrid Strain of Field Corn to European Corn Borer

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DIFFERENCES in the numbers of larvae of the European corn borer, *Pyrausta nubilalis* Hbn., surviving from a given number of eggs laid on various strains of corn have been observed by several investigators. Most of such differences have been associated with the earliness and lateness of the strains, but a few differences have been observed between strains of about the same stage of development during the time when the young borers were becoming established on the plants. In general, the early strains have favored a higher rate of borer survival than the late or midseason strains. Inherent borer resistance contributed by morphological, physiological, or other plant characteristics is distinguishable from the type of resistance resulting from later maturation. Strains having these characteristics have been sought especially for use in breeding borer-resistant corn.

The purpose of this paper is to record the comparative borer resistance of two single-cross hybrid strains of corn of about equal seasonal requirements that were infested naturally by *Pyrausta nubilalis* during 1936. One of the strains has shown a relatively high degree of borer resistance during several seasons when infestations were induced by placing eggs on the plants by hand, whereas the other strain has proved to be borer susceptible when tested by similar methods. The borer-resistant strain also shows promise as a high-yielding strain. The 14 plantings made of it from 1931 to 1935, inclusive, yielded an average of 9 bushels per acre more than the mean yield of all the strains in the tests.

[1] The writer wishes to thank Merle T. Jenkins and J. R. Holbert, Division of Cereal Crops and Diseases, Bureau of Plant Industry, and P. N. Annand and W. A. Baker, Division of Cereal and Forage Insect Investigations, Bureau of Entomology and Plant Quarantine, U. S. Department of Agriculture, for their helpful suggestions in various phases of the work reported, and to express his appreciation to B. A. App and G. T. Bottger, who assisted in harvesting and weighing the samples of kernels, and to Frederick Bennett, Robert Charles and George Ward, who examined the plants for egg masses.

Methods.—Between May 7 and June 5, 1936, 10 plantings of the borer-susceptible single cross Ill. A×Ind. Tr and the borer-resistant single cross Ill. R4×Ill. Hy were made at intervals of two or three days, with two exceptions. The eight rows on the east side of the experimental field were planted on May 7. These rows were followed in succession across the field by nine other plantings of eight rows each. At each planting four rows of R4×Hy followed four rows of A×Tr, but no attempt was made to replicate the plantings. The rows were 42 inches apart and 60 hills long, with the hills within the rows also 42 inches apart. The hills at the time of thinning contained an average of three plants per hill. The object of making 10 plantings within a period of 30 days was to obtain corn in all possible stages of development at the time that corn borer eggs were hatching.

The 12 hills of each row located on the north side of the field were set aside for a study of the relative borer resistance of the two strains under natural infestation. The 15 hills of each row located on the south side of the field provided data on the relative maturity of the strains. The intervening hills were infested by hand with egg masses produced in the laboratory in order to study the rate of borer survival under a wider range of conditions than was possible with the plots that depended on natural oviposition. Dates of tasseling, pollen shedding and silking are the only data from the intervening hills presented in this paper.

Beginning with June 22, all the plants in 12 hills of each row of seven of the 10 plantings were examined for egg masses at average intervals of 2.5 days. The plants were examined 12 times, the last time on July 20. Between August 11 and August 25 the plants of eight of the 12 hills at the north end of each row of all 10 plantings were dissected to determine the number of borers surviving. Records of the egg masses laid and the borers resulting therefrom were kept by hills. Extensive migration of young borers between the plants of a hill precluded the use of the data on a plant basis. The date on which the tassel became visible was recorded for each plant in 124 of the intervening hills of each planting of each strain. The dates when 50 per cent of the plants were shedding pollen and were in silk were obtained from the same plants.

In order to estimate the date upon which the maximum amount of dry matter in the kernels was reached, and thus the date when the plantings of each strain arrived at the mature stage, 16 samples of eight ears each were taken at intervals of two or three days from September 15 to October 16. All the plantings were sampled excepting those of May 7 and 11. In making up the samples, four ears were taken at random from each of the plantings of May 13 and 16. Similarly, three other eight-ear samples were made up on each harvest date by grouping the succeeding plantings. The tips and butts of the ears were chopped off with a corn knife about half way toward the center of the ears and discarded. From the ends of these central portions of the ears 25 perfect kernels were broken off, 13 from one end and 12 from the other. Composite samples of 200 kernels were made from the samples of ears. After determining the harvest weight of these kernels, to the nearest centigram, they were dried at 85 to 90° C in a electric overn. The no-moisture or dry weight was then determined. The dry weights of the samples of kernels were plotted

against the dates of harvest, and a free-hand curve was fitted to the plotted points. From the curve thus obtained an estimate was made of the date when the maximum amount of dry matter was reached in the kernels. In a similar manner, by working with the percentages of moisture in the kernels at harvest, the date when a certain percentage of moisture was attained in the kernels was estimated also.

Relative borer-resistance of the strains.—The numbers of mature or nearly mature borers per 100 plants dissected from the 32-hill plots are given in fig. 1. It may be noted that for each planting the number of borers dissected from strain R4×Hy was less than the number found in strain A×Tr, although there is considerable variation in the relation between the pairs of plots. For example, about .45, .77 and .36 as many

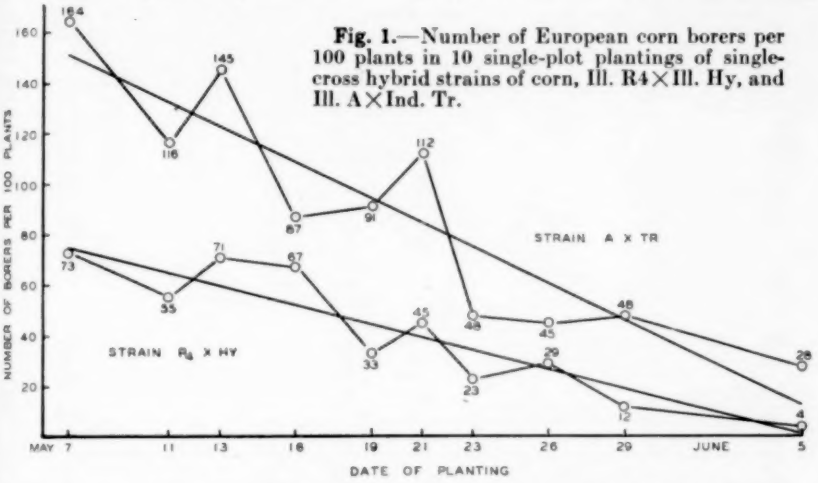

Fig. 1.—Number of European corn borers per 100 plants in 10 single-plot plantings of single-cross hybrid strains of corn, Ill. R4×Ill. Hy, and Ill. A×Ind. Tr.

borers were found in R4×Hy of the May 7, May 16 and May 19 plantings respectively as in A×Tr. However, the plotted points are seen to fluctuate not too widely about the straight lines fitted to them by the method of least squares. The average fluctuation expressed as the standard deviation was calculated to be 20.45 and 9.98 borers in the case of A×Tr and R4×Hy, respectively. Fluctuations of such magnitudes involving only single plots are to be expected, since each value is the resultant of the chance deposition of egg masses by the moths and the chance establishment of the young borers. Since the straight lines appear to fit the data satisfactorily, values read from them are better estimates of the average numbers of borers surviving, in several plots under the given conditions, than the actual numbers found in the single plots. Making the required calculations with values read off from the lines, it is estimated that about .51, .48 and .47 as many borers were in R4×Hy on the May 7, May 16, and May 19 plantings, respectively, as in A×Tr, compared with the values .45, .77 and .36 previously calculated. On the May 23, May 26 and May 29 plantings, calculations made in a similar manner indicate that about .45, .43 and .39 as many borers respectively were in R4×Hy as in A×Tr. As an average of all 10 plantings 88.4

borers were found in the plots of A×Tr as compared with 41.2 borers in R4×Hy. The standard error of these means is ±6.46 and ±3.15, respectively. The difference between the average number of borers found in the two strains is 47.2±7.19 borers. The difference may be considered as highly significant. The mean 41.2 borers is .466 of the mean 88.4 borers. Hence, about .466 as many borers survived in R4×Hy as in A×Tr.

If the numbers of eggs laid on the different plantings of R4×Hy were about equal to the numbers laid on A×Tr, the value .466 may be taken

Table 1.—Number of European corn borers resulting from different levels of egg masses laid on single-cross hybrid strains of corn, Ill. A×Ind. Tr. and Ill. R4×Hy, near Toledo, Ohio, 1936.

Strain of Corn and Date of Planting	1 Egg Mass per Hill		2 Egg Masses per Hill		3 Egg Masses per Hill		4 Egg Masses per Hill	
	No. Hills	Borers per Hill	No. Hills	Borers per Hill	No. Hills	Borers per Hill	No. Hills	Borers per Hill
A×Tr								
May 7	6	2.67	8	4.75	8	5.5	7	7.57
May 11	5	2.6	11	3.45	7	2.71	9	4.33
May 16	5	1	12	2.92	5	3.6	7	3
May 21	11	1.73	6	1.67	8	5.25	6	5.5
May 26	13	.46	7	1.71	2	2.5	4	3.25
Total	*40*		*44*		*30*		*33*	
Average		*1.69*		*2.9*		*3.91*		*4.73*
R4×Hy								
May 7	4	1.25	6	2.17	8	1.88	8	3.13
May 11	5	1.	6	1.5	7	2.29	12	1.75
May 16	9	1.33	6	1.67	6	1.50	8	3.75
May 21	10	1	11	1.64	3	1.67	4	2.25
May 26	9	1.44	9	1.22	6	.0	2	.5
Total	*37*		*38*		*30*		*34*	
Average		*1.2*		*1.64*		*1.47*		*2.28*
Ratio of average numbers of borers in R4×Hy to those in A×Tr (per cent)		71		56.6		37.6		48.2

as a measure of the relative borer resistance of R4×Hy on the scale 0 to 1. In this scale 0 denotes complete resistance or immunity and 1 denotes no greater resistance than the strain with which the comparison is made. Egg records were taken on seven of the 10 plantings. The total numbers of egg masses found on the hills where the plants were dissected are as follows: May 7 and May 11 plantings, 178 on A×Tr and 174 on R4×Hy; May 16 and May 21 plantings, 149 on A×Tr and 132 on R4×Hy; May 26 planting, 54 on A×Tr and 54 on R4×Hy. On these five plantings the total is 381 masses on A×Tr and 360 masses on R4×Hy. On the last two plantings, made on May 29 and June 5, a total of 53 masses was found on A×Tr and 37 masses on R4×Hy, and these numbers of masses resulted in 71 and 15 borers, respectively. Using 15 as the mean number of eggs per mass, the estimated percentage of borer survival is 8.9 and 2.7 respectively. On the basis of these percentages the relative borer resistance of R4×Hy is estimated to be .303. Considering that only slightly fewer egg masses were laid on R4×Hy of the five earliest plantings examined than on A×Tr and that the relative borer resistance of R4×Hy on the last two plantings was greater than the value .466 would indicate, it appears this value may be con-

sidered as a good average estimate of the borer resistance of R4×Hy on all the plantings. There is some indication that the borer resistance of R4×Hy increases with later planting, but the data from the naturally infested plants are not extensive enough to determine this point definitely.

Past experiments indicate that the borer resistance of R4×Hy compared with local open-pollinated varieties would be about the same as when the comparison is with A×Tr. This supposition is based on the

Table 2.—Height, mean tasseling date, and mid-date of pollen shedding and silking of single-cross hybrid strains of corn, Ill. A×Ind. Tr and Ill. R4×Ill. Hy, near Toledo, Ohio, 1936.

Strain of Corn and Date of Planting	Height of Plants, Cm.*				Mean Date of Tasseling	Date 50 Per Cent of Plants Shedding Pollen	Date 50 Per Cent of Plants in Silk
	June 26	July 8	July 16	July 21	Days from June 30	Days from June 30	Days from June 30
A×Tr							
May 7	127	170	193	200	12.7	22	25
May 11	115	160	186	196	16.	26	28
May 13	107	158	195	207	17.2	27	28
May 16	99	144	177	189	18.1	28	30
May 19	92	139	178	193	19.5	30	32
May 21	85	128	167	181	20.3	31	33
May 23	83	131	173	187	21.4	33	34
May 26	74	119	159	174	24.5	35	37
May 29	63	110	153	171	28.3	39	40
June 5	43	88	132	151	31.5	42	44
Mean	*88.8*	*134.7*	*171.3*	*184.9*	*21.*	*31.3*	*33.1*
R4×Hy							
May 7	125	179	208	219	20.2	23	26
May 11	112	159	198	210	23.1	27	29
May 13	107	156	201	215	23.7	28	30
May 16	99	144	183	199	24.3	28	31
May 19	89	132	180	201	27.9	33	34
May 21	84	126	169	188	27	33	34
May 23	81	125	175	194	29.4	34	35
May 26	70	114	156	174	33.7	38	39
May 29	55	102	140	160	36.6	40	41
June 5	42	88	128	148	39.7	44	46
Mean	*86.4*	*132.5*	*173.8*	*190.8*	*28.6*	*32.8*	*34.5*

* To the tip of the leaves extended straight up of a sample of 12 hills.

fact that the percentage of borer survival in A×Tr was about the same as in the local varieties on the plantings made in 1933, 1934 and 1935. Eight plantings in these years included A×Tr and the Johnson strain of Clarage and showed that the mean percentage of borer survival was 8.5 and 8.9 respectively. Six plantings included A×Tr and the Mast strain of Woodburn and gave mean percentages of 7.5 and 7.4 respectively.

Level of egg population as a factor in borer resistance.—The data obtained from the individual hills were classified according to the number of egg masses laid on them. The last two plantings were not considered because of the paucity of data. The average numbers of borers per hill for each planting and the averages of all plantings are given in table 1 for hills where one, two, three and four or more egg masses were found. The data from A×Tr and R4×Hy are given separately.

Referring to table 1, the 40 hills of A×Tr where one egg mass was found averaged 1.69 borers, as compared with 1.2 borers per hill in 37 hills of R4×Hy. The number of borers in R4×Hy was 71 per cent of

the number in A×Tr, and the relative borer resistance of R4×Hy in this case was .71 on the scale previously discussed. In a similar manner the relative borer resistance of R4×Hy, on the basis of hills where two, three and four or more egg masses were found, was calculated to be .566, .376 and .482 respectively. These data suggest that the borer resistance of R4×Hy compared with A×Tr might be greater under higher levels of infestation, but further work is necessary before this can be shown conclusively.

Relative maturity and leaf area of the strains.—The relative borer population per given sample of R4×Hy and A×Tr has been used in the preceding calculations as a measure of their relative borer resistance

Table 3.—Percentage of moisture at harvest in samples of kernels of single-cross hybrid strains of corn, Ill. A×Ind. Tr and Ill. R4×Ill. Hy, near Toledo, Ohio, 1936.

Date of Planting	Strain of Corn	Mean Percentage of Moisture			
		Harvested Sept. 15 to 21	Harvested Sept. 23 to 28	Harvested Sept. 30 to Oct. 7	Harvested Oct. 9 to 16
May 13 and 16	A×Tr	35.3	32	31	27
	R4×Hy	34.4	31	29	25.8
	Difference	−.9	−1	−2	−1.2
May 19 and 21	A×Tr	37.6	33.5	33.2	29
	R4×Hy	36.5	32.3	31.3	27.2
	Difference	−1.1	−1.2	−1.9	−1.8
May 23 and 26	A×Tr	40	35.8	34	31.5
	R4×Hy	40	36.7	33.5	29.6
	Difference	0	+.9	−.5	−1.9
May 29 and June 3	A×Tr	46.7	41.5	38.7	35.4
	R4×Hy	48.2	42.4	39.2	35.6
	Difference	+1.5	+.9	+.5	+.2

on the basis of about the same number of egg masses hatching on the strains. Ficht (1932) has shown that the leaf area per unit of field area is a factor determining the rate of borer survival. Neiswander, Polivka & Huber (1928) have shown that the maturity of the plants is also a factor determining the rate of borer survival. Hence the relative borer population per sample may be used directly, without correction, as a measure of relative borer resistance only if the leaf area and the maturity, or stage of plant development, of the two strains are about the same. The heights of the two strains on four dates during the oviposition period, the mean date of tasseling, and the dates when 50 per cent of the plants were shedding pollen and were in silk are given in table 2 for each of the plantings. The percentages of moisture at harvest in the samples of kernels are given in table 3.

The amounts of dry matter contained in a given number of kernels at harvest are not given because the data were too variable to enable definite determination to be made of the date when the maximum amount of dry matter was attained. Evidently much larger samples of ears are necessary for studying this point. The plotted data indicated, however, though not conclusively, that the amount of dry matter in the last six plantings continued to gain even up to the time of harvesting the final samples on October 16.

Considering the question of the stage of plant development, it may be noted from table 2 that as an average of all the plantings the mean date of tasseling of R4×Hy was 28.6 days after June 30, or 7.6 days after the mean tasseling date of A×Tr. This difference in tasseling was largely due to a delay in the eclosion or emergence of the tassels of R4×Hy from their leaf wrappings and not to a difference in the growth of the tassels. This conclusion is upheld by the data in table 2 which shows that the pollen of R4×Hy was shed only 1.5 days after that of A×Tr and that the silks appeared only 1.4 days later. Irrespective of whatever effect the delayed tassel eclosion of R4×Hy might have had on the borer survival, it does not seem probable that the small difference in plant development as evidenced by the time of pollen shedding and silking could have accounted for the great difference in the final borer population in the two strains.

The strains are compared in table 3 with respect to maturity as measured by the percentage of moisture in the kernels at harvest. The data from the May 13 and May 16 plantings show that the percentage of moisture in A×Tr decreased from 35.3 when the harvest was from September 15 to 21, to 27 when the harvest was from October 9 to 16. The percentage of moisture in R4×Hy was slightly less during each of the four harvest periods given in the table, the differences being .9, 1, 2, and 1.2 respectively. Differences of 1.1, 1.2, 1.9 and 1.8 respectively were found to be in favor of R4×Hy also in the May 19 and May 21 plantings. The percentage of moisture in R4×Hy was about the same as in A×Tr during the first half of the harvest period but slightly less during the last half when the plantings were made on May 23 and 26. In the May 29 and June 5 plantings the percentage of moisture in R4×Hy was greater than in A×Tr throughout the harvest but the difference became less as the harvest was made later. With the exception of the last two plantings, these data indicate that although the ears of R4×Hy began their development about 1.4 days later than A×Tr they reached a given moisture content and presumably maturity at harvest about the same time or slightly ahead of A×Tr.

Considering the question of the relative leaf area of the two strains, reference must be made to data obtained in 1935 and to the data on plant height given in table 2. In 1935 the leaf area (in square cm.) of each leaf of a plant from each of five consecutive hills of R4×Hy and A×Tr was calculated during the growing season by the formula $a\left(\frac{b}{4}+\frac{c}{2}\right)$ where a is the length of the midrib, b is the basal width, and c is the mid-width of the leaf in cm. The total leaf area of each plant was expressed as the number of square cm. per cm. of height. The average values (square cm. per cm. of height) from five plants of each strain for given plant heights were calculated to be as follows: 150 cm. high, R4×Hy 27.6 and A×Tr 28.4; 180 cm. high, R4×Hy 30.8 and A×Tr 33.9; 210 cm. high, R4×Hy 34 and A×Tr 35.7. It is assumed that the relative leaf area of the two hybrid strains remains rather constant from year to year.

Referring to the mean values of table 2, it may be noted that between June 26 and July 16, 1936, the difference between the heights of the

two strains was only about 2 cm. This is a negligible amount considering the height of the strains. Using the data in the preceding paragraph, plants of A×Tr 150 cm. high would provide about 3 per cent more leaf area than plants of R4×Hy of equal height. Of all the egg masses laid on the 1936 plantings, 76 per cent were laid on plants less than 157 cm. high. Dissections made in 1933 showed that 75 per cent of the borers hatching from 14,400 eggs died within four days. In view of these findings it does not seem probable that the slightly greater leaf area of A×Tr compared with R4×Hy could have accounted for the much greater final borer populations in A×Tr.

Summary.—Two single-cross hybrid strains of corn of about the same area of leaf surface required about the same length of season to attain given stages of plant development. One strain, Ill. R4×Ill. Hy, proved to be borer resistant compared with the other strain, Ill. A×Ind. Tr. The number of borers reaching maturity in 10 plantings of strain R4×Hy made in 1936 was equal to 46.6 per cent of the number in strain A×Tr. The numbers of egg masses laid on the strains were about the same. It is not probable that the small differences noted between the strains in leaf area and stage of plant development accounted for the large differences in final borer populations.

Past experiments indicate that the borer resistance of single-cross R4×Hy compared with local open-pollinated varieties Clarage and Woodburn would be about the same as when the comparison is with single-cross A×Tr.

Strain R4×Hy also shows promise as a high yielding strain. Over a period of five years this strain gave a yield of 9 bushels per acre more than the mean yield of all the strains in the tests.—3-15-37.

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A Recent Pest of Alfalfa

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During the late summer and fall of 1936, alfalfa in Louisiana was defoliated by the velvet-bean caterpillar, *Anticarsia gemmatilis* Hbn. In Louisiana this insect is commonly known as the soybean caterpillar because it has been primarily a pest of soybeans. It has been observed in this section that the moths select soybeans in preference to velvet beans for oviposition, even when the two crops are grown in adjacent fields.

Although the velvet-bean caterpillar has been a pest of economic im-

portance for many years in the southeastern states, it was not until 1929 that attention was called to its presence in Louisiana. Both Hinds (1930) and Douglas (1930) reported that *Anticarsia gemmatilis* seriously damaged soybeans in the southern part of the state. Since that time the insect has been a yearly visitor to Louisiana; some years many fields of soybeans have been completely defoliated, whereas in other years the damage has been less severe.

So far as is known, the velvet-bean caterpillar has never been reported to be a serious pest of alfalfa in the United States. In fact, the only mention of this pest feeding on alfalfa in this country was made by Harned (1929). He makes the statement that *Anticarsia gemmatilis* was found in one field of alfalfa in Yazoo county, Miss.

Besides velvet beans and soybeans, plants which have been most frequently reported as being attacked by the velvet-bean caterpillar, it has been reported that peanuts, kudzu vines, horse beans, cotton (adjacent to soybeans), tender locust sprouts (*Robinia pseudocacia*), cowpeas, and coffee weeds (*Sesban macrocarpa*) are sometimes attacked by this pest.

It was observed in the fall of 1936 that oviposition occurred on the leaves and stems of *Phaseolus latheroides* (a legume planted between varieties of soybeans to separate them on the experiment station farm at Baton Rouge, La.). The larvae completed their development on this plant. Fields of peanuts growing some distance from soybeans were also defoliated by the caterpillars.

These caterpillars were observed in the alfalfa fields in East Baton Rouge parish until frost and a close check was made of their activities. The crop of alfalfa which would normally have been cut about September 20 was completely defoliated. In most cases the defoliated alfalfa stems were cut and left in the fields; and when the new growth had reached a height of about 3 inches eggs were again noticed on the leaves and stems (this was about October 1). About two weeks later all stages of the caterpillars and eggs were present on the alfalfa plants and soon only the bare stems remained. After about October 1 it was observed that practically no velvet-bean caterpillar eggs were found on soybeans. It appears, therefore, that in the fall when the soybeans approach maturity the growing alfalfa is more attrative to the moths.

A survey made in the alfalfa-growing section of southern Louisiana revealed that velvet-bean caterpillars were present in practically every field of alfalfa examined, although in some of the fields the damage was not extensive since practically 100 per cent of the eggs were parasitized by the egg parasite *Trichogramma minutum* Riley. Also, in some fields a parasitic fungus, *Spicaria prasina* (Maulb.) Saw, helped to keep the caterpillars in check.

It is a common practice in southern Louisiana to reseed alfalfa each fall. According to the reports of several reliable plantation foremen, the young seedlings have been defoliated many years by a green caterpillar before the coming of cool weather, resulting in a greatly reduced stand the following year. It is possible that the velvet-bean caterpillar was responsible for some of this damage. Although alfalfa was seeded at the normal time in the fall of 1936, unusually dry weather prevented its mak-

ing the normal early growth; hence there was no damage to the seedlings by the caterpillars.

Since the velvet-bean caterpillar disappears after the first heavy frost, the later alfalfa is seeded the less likely it is to be damaged by the pest. But it must be kept in mind that unless the fall alfalfa seedlings have established a good root system before freezing weather, they are likely to be killed.

Preliminary field and cage tests were made with four samples of calcium arsenate. All of these samples gave excellent control of the caterpillars, but the one which contained 4.7 per cent water-soluble As_2O_5 showed slight injury to the plants; the other three samples, which contained .35 per cent, .65 per cent, and .68 per cent water-soluble As_2O_5 respectively, did not injure the plants. It is realized that calcium arsenate cannot be safely applied to alfalfa which is soon to be cut for hay, but it can be used, if it becomes necessary, to prevent destruction of fall seedlings by the caterpillars.

Summary.—*Anticarsia gemmatilis*, the velvet-bean caterpillar, was a serious pest of alfalfa in southern Louisiana during the late summer and fall of 1936. The egg parasite *Trichogramma minutum* and a parasitic fungus, *Spicaria prasina*, were factors in reducing the infestation in some areas. At present, control is limited to poison control on fall seedlings, and to the delay of fall plantings to prevent defoliation of the seedlings by the caterpillars.—1-7-37.

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Egg and Larval Populations of European Corn Borer

In Relation to Time of Planting and Yields of Sweet Corn

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Late-planted corn is less subject to infestation by the European corn borer, *Pyrausta nubilalis* Hbn., than corn planted earlier in the season, owing to its partial escape from oviposition and to lower rates of survival of the progeny, as a result of the relatively early developmental condition of the plants during the oviposition period. This fact has been recorded previously by other workers (Caffrey, 1928; Ficht, 1936; Huber, Neiswander & Salter, 1928; Marston & Dibble, 1930; Patch, 1929),

[1] The authors gratefully acknowledge the valuable suggestions given by W. A. Baker, in charge of federal European corn borer research, under whose direction these investigations were conducted.

Table 1.—Summary of European corn borer egg and larval populations and yields of corn in seasonal plantings of sweet corn near Toledo, Ohio, in 1934, 1935 and 1936.

Planting Date	No. Eggs Per Plant	No. Larvae Per Plant	Average Per Acre Yield in Thousands*	
			No. Uninjured Salable Ears	Pounds of Corn† for Canning
1934—One Strain				
May 4	7.37	1.4	6.4	3.9
May 11	6.83	.67	5.1	3.1
May 18	3.13	.47	5.4	2.8
May 25	2.5	.33	6.6	4.3
June 1	.43	.23	10.4	5.9
June 8	.0	.03	5.2	6.3
June 15	.0	.03	1.1	5.8
June 22	.0	.0	.5	5.9
June 29	.0	.0	.0	5.3
July 5	.0	.0	.2	4
Average	*2.03*	*.32*	*4.1*	*4.7*
Mean Standard Error				
Plantings	*1.441*	*.159*	*.701*	*.424*
Averages	*.456*	*.05*	*.223*	*.134*
Significant Difference				
Between plantings	*5.66*	*.62*	*2.76*	*1.67*
From average	*3.09*	*.34*	*1.51*	*.91*
1935—Three Strains				
May 1	8.65	2.93	8	3.16
May 8	7.89	2.91	8.5	3.24
May 15	8.48	2.16	8.6	2.98
May 22	5.89	1.53	10.6	3.35
May 29	4.23	1.23	8.8	3.13
June 5	2.03	.64	10.6	3.28
June 12	.73	.46	11.1	3.29
June 19	.08	.37	11.8	3.08
June 26	.0	.1	11.4	3.22
July 3	.0	.05	12.6	3.21
Average	*3.8*	*1.24*	*10.2*	*3.19*
Mean Standard Error				
Plantings	*.83*	*.219*	*.537*	*.114*
Average	*.263*	*.069*	*.17*	*.036*
Significant Difference				
Between plantings	*2.44*	*.64*	*1.58*	*.34*
From average	*1.72*	*.46*	*1.11*	*.24*
1936—Five Strains				
May 1	35.78	7.62	5.6	2.89
May 8	27.14	5.62	6.9	3.06
May 15	22.84	3.36	10.9	3.79
May 22	12.32	2.17	13.8	4.52
May 29	12.66	1.2	12.9	4.34
June 5	11.02	1.86	13.7	4.44
June 12	16.7	2.17	10.9	3.83
June 19	12.4	2.13	10.6	3.65
June 26	5.2	2.34	9.6	3.81
July 3	4.88	1.09	7.9	3.29
Average	*16.09*	*2.96*	*10.3*	*3.76*
Mean Standard Error				
Plantings	*1.387*	*.296*	*.31*	*.097*
Averages	*.439*	*.093*	*.098*	*.031*
Significant Difference				
Between plantings	*3.94*	*.84*	*.88*	*.28*
From average	*2.87*	*.61*	*.64*	*.2*

* Harvested at canning stage of corn; yield reflects influence of all seasonal conditions.
† Based on whole, untrimmed ears in 1934, and on cut corn in 1935 and 1936.

and particularly, with reference to sweet corn, by Hervey (1932) for one-generation borer conditions in western New York. In view of the relatively short duration of moth flight in the one-generation area in the United States, and the wide seasonal range adapted to sweet corn culture, regulation of the planting time of sweet corn to escape severe borer infestation appeared to be a generally feasible practice, particularly with reference to canning corn production. The investigations reported herein

were undertaken to determine the practicability of late planting of sweet corn in northern Ohio or similar sections of the country, to reduce corn borer infestation, when all additional seasonal factors, including weather conditions, and injury by other insect pests, notably the corn ear worm, *Heliothis obsoleta* Fab., were taken into account. The net yield of usable corn produced in the different plantings reflects the total influence of all seasonal factors, including damage by the resultant borer populations, and therefore affords an indication of the relative value of the practice of late planting for the area under observation.

These experiments were conducted during 1934, 1935 and 1936 near Toledo, Ohio, on experimental plots operated by the U. S. Department of Agriculture. Similar methods were employed each year, with changes only in the number of sweet corn strains tested, the size of samples, and the number of replications. A series of 10 weekly plantings were made each year, beginning on May 4 in 1934 and on May 1 in 1935 and 1936. Each planting was replicated three times in 1934, four times in 1935 and five times in 1936. Randomized blocks were used in the 1934 and 1935 experiments, and a modified Latin square in 1936. A single strain, Country Gentleman, was tested in 1934. In 1935 the scope of the tests was enlarged by inclusion of the hybrids Tendergold and Golden Cross Bantam. In 1936 Spanish Gold and Howling Mob were added to the strains named above, the former to widen the seasonal range of maturity of the plantings, and the latter to include an additional white strain. The strains matured in the following order: Spanish Gold, Tendergold, Howling Mob, Golden Cross Bantam and County Gentleman. The seed used was locally adapted, and was purchased in the open market each year from the same source. Resultant borer egg and larval populations and the yields of sweet corn were determined for each strain planting.

The results of the 1934, 1935 and 1936 experiments are not presented in detail here; they are summarized by seasons in table 1. Discussion of the results is confined mainly to the contents of the table. Significant differences presented in the table were determined by statistical analyses of the data, following Snedecor (1934). Differences in the results of the magnitude of the figures given are significant on the basis of odds of 19:1. Lesser differences are the result of experimental error.

Relation of egg populations to time of planting sweet corn.—In the 1934 and 1935 experiments 10 random plants were examined for eggs in each plot, totaling 30 plants per strain planting in 1934 (three replicated tests), and 40 plants per strain planting in 1935 (four replicated tests). In the 1936 experiment the number of plants examined was reduced to two per strain replicate, totalling 10 plants per strain planting (five replicated tests). Heavy oviposition in 1936 offset the small size of the sample taken that year. Egg counts were made at least twice weekly during oviposition, as this practice overlapped the five-day mean hatching time of eggs in the field. The number of eggs were counted in each mass found, and the position of the mass on the plant was marked by a small clip attached nearby on the leaf, to avoid duplication of records.

In 1934 the first eggs were found on June 27 and the last on July 19, with peak oviposition about July 3. In 1935 the oviposition record extended from July 1 to 30, with heaviest egg laying about July 12. In

1936 the first eggs were found on June 14, and owing to the occurrence of a partial second generation of moths the period of examination was prolonged to August 24. First-generation oviposition in 1936 occurred from June 14 to July 23, and second-generation oviposition from August 1 to 24, with peaks on July 9 and August 13 respectively. Of the total number of eggs recorded in 1936, 69.67 per cent were laid by the first-generation moths and 30.33 per cent by the second-generation moths. First-generation oviposition was confined almost entirely to the earlier plantings and comprised nearly the entire egg population recorded in the plantings of May 1 to May 29, whereas second-generation oviposition occurred chiefly in the plantings of June 5 to July 3. Overlapping of the two generations occurred in the mid-season plantings. The distribution of eggs reflected the relative conditions of attractiveness of the different plantings during moth flight of the two broods. During oviposition by the first-generation moths the early plantings of sweet corn were in the early tassel stage and relatively taller than the later plantings, and consequently received the major portion of the first-generation eggs. During oviposition by the second-generation moths, however, the later plantings were approximately the same height as the early plantings, but at a more attractive stage of tassel development, and therefore became the preferred hosts.

The data on the distribution of eggs among the different strain plantings in 1934, 1935 and 1936, computed to per plant basis, reflect the relative developmental condition of the plantings during oviposition and show the association of lower egg populations with late planting. Considering the average strain results in the different years, as given in table 1, the five earliest plantings contained 100 per cent of the total number of eggs in 1934, 92.6 per cent in 1935, and 68.9 per cent in 1936. The 1936 results reflect the confinement of second-generation oviposition to the later plantings. When only the first-generation results are considered, the five earliest plantings in 1936 were found to contain 97.2 per cent of the eggs, which is comparable with the data obtained in the 1934 and 1935 experiments. The results indicate, therefore, that under single-generation conditions the corn planted early in June and thereafter will escape with relatively light egg infestations. That protection of late-planted corn is afforded over a wide range of intensity of infestation is shown by the relatively great increase in the egg populations of the early plantings in 1936 over the previous two years, in contrast with the increase in the later plantings, when second-generation oviposition is not considered. The presence of a partial second generation of the borer in 1936 obviously lessened the protection from egg infestation otherwise obtained by late planting.

Relation of larval populations to time of planting sweet corn.—Larval populations were determined by dissection of 10 random plants in each plot, totalling 30 plants per strain planting in 1934 (three replicated tests), 40 plants per strain planting in 1935 (four replicated tests), and 50 plants per strain planting in 1936 (five replicated tests). Plant dissections were made August 7 to 9 in 1934, August 8 to 29 in 1935, and July 21 to September 22 in 1936. In the 1935 and 1936 experiments the population determinations were delayed, when feasible, until just prior

to harvest of the strain plantings (with exception of the late plantings) to afford supplementary data on ear infestation. Plant dissections were completed before extensive borer migration began. As the larvae in the later plantings in 1936 developed from second-generation eggs laid late in the season, the migration factor was not considered. Certain of the strain plantings, however, were dissected when the larvae were less than half grown, to meet harvest requirements.

Separation of first and second-generation larvae was possible owing to differences in size and almost complete segregation of each in the early or late plantings of sweet corn. Distribution of the larvae among the plantings corresponded with the distribution of eggs. Larval populations of the earlier plantings, from May 1 to 29, were mainly of the first generation, whereas those of the later plantings, from June 5 to July 3, were composed chiefly of borers of the second generation. The proportions of first and second-generation larvae, 68.12 and 31.88 per cent respectively, corresponded closely with the proportions of eggs laid by the respective broods, namely, 69.67 and 30.33 per cent.

The data on the larval populations in the plantings of different sweet corn strains in 1934, 1935 and 1936, computed to per plant basis, show that relatively low larval populations were associated with the late plantings of sweet corn, and that the resultant larval populations in general corresponded with the relative rates of oviposition in the different plantings, reflecting the developmental condition of the different plantings during oviposition. When the average results for the strains tested in each year were considered, the five earliest plantings of sweet corn were found to contain 98.1 per cent of the total larvae recorded in 1934, 86.9 per cent of the larvae recorded in 1935, and 67.6 per cent of the larvae recorded in 1936. The 1936 data reflect the influence of second-generation oviposition. When larvae of the first generation only were considered, it was found that the five earliest plantings of sweet corn in 1936 contained 96.6 per cent, a figure which is comparable to the results obtained in the 1934 and 1935 experiments under conditions of a single generation of the borer. A close association was shown in the proportions of egg and larval populations contained in the five earliest plantings. The results indicate, therefore, that under single-generation conditions the plantings of sweet corn made during the first week in June and thereafter contained relatively low larval populations as a result of their escape from egg infestation. Since resultant infestations in the different plantings of sweet corn were found to be associated with the relative developmental condition of the plantings during oviposition, it is apparent that seasonal influences that affect both the development of the corn and the occurrence of the borer will also modify to some extent the intensity of infestation of the various plantings in different seasons. It is significant in this connection, however, that the relative intensity of larval populations of the first generation in the late plantings remained low in 1936, under conditions of a much higher natural infestation, as reflected in the early plantings, than prevailed in the seasons of 1934 and 1935. This is indicative that late planting affords protection against severe larval infestation over a wide range of borer abundance. As in the case of egg infestation, it is obvious, however, that the degree of protection derived

from late planting is lessened in the presence of a partial second generation of the borer, such as occurred in 1936.

Relation of yield to time of planting sweet corn.—In the 1934 experiment the entire plots were harvested to determine the resultant planting yields. The plot stands ranged from 40 to 60 plants, with an average stand of 51 plants, totalling on an average 153 plants per strain planting (three replicated tests). To place the results on a comparative basis for analysis, the yield of each plot was divided by the number of plants harvested, and multiplied by 100. In the 1935 and 1936 experiments a uniform sample of 20 consecutive plants was harvested in each plot, totalling 80 plants per strain planting in 1935 (four replicated tests), and 100 plants per strain planting in 1936 (five replicated tests). The strain plantings were harvested at canning stage of the ears, approximately 23 days after 50 per cent of the silks appeared. All silked ears, regardless of developmental stage, were removed, and the mature ears were determined by husking. The number and weight of uninjured and injured mature ears were then recorded. Canning yields were based on the total production of mature ears, after counting, weighing, and discarding those too severely injured to warrant trimming. In the 1934 experiment the canning yields comprised the total weight of usable mature ears, without consideration of losses due to injured kernels. In the 1935 and 1936 experiments the injured portions of ears were trimmed, as in general canning practice, and the weight of usable cut corn was recorded. To facilitate seasonal comparisons, the mean results for each year were computed to acre yields on the basis of 13,560 plants per acre, and the yields of uninjured salable ears (by number) and the canning yields (by weight) for the three years of tests were recorded in terms of thousands per acre. The average results for the strains tested in the different seasons are summarized in table 1. In comparing the yield data by plantings, it should be borne in mind that the results reflect the influence of all seasonal factors and tend to show the relative value of late planting as a practice to reduce borer infestation, when all factors, including damage by the borer, are taken into account.

In 1934, on the basis of a single strain, Country Gentleman, production of uninjured salable ears in the plantings made on May 4, May 25 and June 1 was significantly above the average of all the plantings. Average yields were produced in the plantings made on May 11 and 18 and June 8, and yields significantly below average in the plantings made on June 15, 22 and 29 and July 5. The results reflect a season of light borer infestation and unusually heavy corn ear worm infestation, the latter gaining in severity as the season advanced and reducing production of uninjured salable ears in the late plantings to negligible numbers. The majority of ears, however, showed only light injury, and could be trimmed for canning. On the basis of whole, untrimmed ears, the production of canning yields was significantly above average in the plantings made on June 1, 8, 15 and 22; average in the plantings made on May 4 and 25, June 29 and July 5; and significantly below average in the plantings made on May 11 and 18.

In 1935, based on the average results of three strains, Tendergold, Golden Cross Bantam and Country Gentleman, the production of un-

injured salable ears was significantly above the average of the plantings in the plantings made on June 19 and 26 and July 3; average in the plantings made on May 22, June 5 and June 12; and significantly below average in the plantings made on May 1, 8, 15 and 29. When the injured portions of the ears were trimmed, and the uninjured cut corn recorded, as for canning, none of the plantings was found to be significantly above or below the average of the plantings, in weight of cut corn produced. Corn ear worm infestation was relatively light in 1935. The early plantings of sweet corn showed little infestation by this insect, and relatively small increases were found in the later plantings.

In 1936, based on the average results of five strains, Spanish Gold, Tendergold, Howling Mob, Golden Cross Bantam and Country Gentleman, the production of uninjured salable ears was above the average of all the plantings in the plantings made on May 15, 22 and 29 and June 5 and 12; average in the plantings made on June 19 and June 26; and below average in the plantings made on May 1 and 8 and July 3. The plantings of May 1 and 8 showed the lowest yields. When the injured ears were trimmed, as for canning, and the uninjured cut corn recorded, the yield was significantly above average in the plantings made on May 22 and 29 and June 5; average in the plantings made on May 15 and June 12, 19 and 26; and significantly below average in the plantings made on May 1 and 8 and July 3. Corn ear worm infestation was light in 1936, with little increase in the late plantings.

Results and conclusions.—The results of the experiments conducted near Toledo, Ohio, in 1934, 1935 and 1936, and representative of single-generation borer conditions in northern Ohio, indicated that a high degree of protection from borer infestation was afforded to sweet corn planted early in June and later, due to partial escape from oviposition, and that resultant borer populations in the late plantings were not materially affected by the seasonal abundance of the insect, when a single generation of the borer was considered. The late-planted corn was the preferred host for oviposition by a partial second generation of moths in 1936. On the other hand, in the season of 1934, late-planted corn was more severely infested by the corn ear worm than corn planted earlier in the season. Increase of corn ear worm infestation was also noted in the late plantings of sweet corn in the 1935 and 1936 seasons. However, the influence of the corn ear worm in the late plantings, although manifested in an increase in the number of injured ears, did not materially reduce the amount of corn available, after trimming, for canning. The experimental results show that favorable yields of sweet corn were obtained from the plantings made as late as the first week in June to the first week in July, under northern Ohio conditions, with satisfactory protection from infestation by the borer. Late-maturing strains were not excepted, as shown by the results obtained with Country Gentleman. But, as Hervey (1932) has pointed out, the practice of late planting holds greater possibilities in the production of canning corn, which may be seasonally delayed without serious inconvenience, than in the production of market corn, which enters into competition for the prevailing high prices obtained early in the season. The canner, however, is confronted with the necessity of operating expensive factory equipment over a

longer period of time to accommodate crops from large acreages. He must balance this factor against the value of late planting by the grower to decrease borer infestation and the consequent lessening of the danger of contamination in the canned product, and a possible reduction of labor cost incident to the trimming of injured ears.

Summary.—Ten weekly plantings of different strains of sweet corn, from the first week in May to the first week in July, were made near Toledo, Ohio, in 1934, 1935 and 1936, to study the relation of time of planting to resultant egg and larval populations of the European corn borer, *Pyrausta nubilalis* Hbn., and corn yields, when all seasonal factors were considered. Under northern Ohio conditions, satisfactory protection from borer infestation, and favorable corn yields, were obtained under single-generation conditions in plantings made from the first week in June to the first week in July. In 1936 a partial second generation of moths reduced the protection otherwise gained by late planting. Late-planted corn was more severely infested by the corn ear worm, *Heliothis obsoleta* Fab., but consequent injury of the ears was not reflected in the yield of cut corn for canning. In an evaluation of the economy of late planting to reduce borer infestation, the market gardener must consider the relatively higher prices prevailing early in the season, while the canner is concerned with factory operation, labor costs in handling the ears, and danger of contamination of the canned product.

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Observations on Brood X
Of the Periodical Cicada in Maryland

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A class project was organized to study the periodical cicada, particularly with a view of checking the biology and determining either experimentally or by observation the causes of some of the phenomena and the procedure followed by nymphs and adults in certain activities. This paper is a summary of the class reports, supplemented by the observations of several members of the staff.[1]

[1] Acknowledgment should be made to the following students: Earl J. Anderson, Arthur Buddington,

How and when does the cicada construct its soil burrows?—Soil excavations were started in October and carried on up to the time of emergence except during extreme midwinter weather. During October and November 1935, short soil burrows were found at depths usually ranging from 12 to 18 inches. These burrows were 3 to 4 inches in length. In every burrow at this depth there was at least one tree or shrub rootlet. The small collembolan, *Folsomia fimetaria*, was present in many burrows. When disturbed the cicada nymphs would crawl slowly. On March 4, 1936, diggings in a variety of locations showed little change in depth or activity over that of the previous autumn. Beginning March 7 diggings were made weekly in several widely separated locations. Between March 4 and 7 little change was noted, but by March 15 the nymphs had moved upward to an average depth of 15 inches from the surface. On March 21 the average distance from the surface was 12 inches, and at this stage was noted for the first time considerable loose dirt in the bottom of the tunnel. The burrows ran in a generally vertical direction, though most of them were slightly serpentine. By March 28 most of the burrows were within 7 inches of the surface. On April 4 many of the burrows were within 1 inch from the surface and turret building was noticed generally throughout the areas under observation. The question of how long before emergence these burrows are built to the surface appears very definite, as the first emergence noted at College Park was May 11, with the peak about 10 days later. The insect remains in the completed burrow approximately three weeks before emergence.

The length of the burrows is often much greater than is commonly supposed. On March 28th the burrows averaged from 6 to 10 inches in length while just prior to emergence many were found to be 12 inches in length. In those cases where turrets are formed the chamber has to be opened at the surface, but where there is no turret formation the hole apparently remains closed until shortly prior to emergence.

When does the cicada nymph cease feeding activities?—During the month prior to emergence no feeding was observed in the field and many of the burrows had no roots in them to a depth of 6 to 8 inches below the surface. In the laboratory, cicadas were reared in soil, potatoes and several other media, but showed no signs of feeding during this period.

Has actual emergence from the soil been observed?—It has been repeatedly stated that no one has actually seen a cicada leaving its burrow. During the 1936 brood, numerous observers witnessed cicadas coming out of the ground near batteries of flood lamps. Illumination of lamps with a wattage as great as 2500 did not deter them from leaving the burrows and migrating to trees and shrubs.

When does the cicada open the hole?—The general reaction of the species was not determined definitely, but careful observations in late afternoon and early evening during the heavy emergence showed that many holes were opened not more than one or two hours prior to actual emergence from the soil.

Does the cicada orient itself promptly?—While a very few nymphs

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were noted to wander aimlessly for a minute or more, practically all the cicadas upon leaving the burrow pursued a line as straight as the vegetation would permit in the direction of a nearby tree or shrub. In one closely clipped lawn thousands of cicada could be noticed within the range of a flashlight, all heading directly toward a nearby plant. The nearest plant was not always the one to which the nymph moved, but none was observed to orient itself with reference to a plant at a great distance.

Where can emergence take place?—Due to the fact that the nymph carefully anchors itself to the limb, leaf or trunk of the host plant before the start of the last moult, it has been stated that this attachment is necessary and that the insect would not be able to emerge if it fell to the ground. Normal adults were not found in any of the cases where they had been removed from the plant. In one experiment 100 nymphs were removed from a tree trunk after they were securely anchored and none of them were fully developed the next morning. Many were able to

Table 1.—Emergence of cicada in three types of shelters.

Shelter	First Emergence	Peak Emergence	Last Emergence
1	May 5	May 7	May 13
2 (check)	May 19	May 24	May 29
3	May 6	May 9	May 21

leave the last nymphal shell, often with apparent difficulty, while many others were caught by the drying body wall. None had fully expanded wings.

What percentage of cicadas fail to emerge?—It was noticed all through the period of heavy emergence that a certain number of cicadas remaining attached to the trunks of trees were unable to extricate themselves from their shell. Apparently those emerging from the ground toward the end of the day's emergence, that is, near or after midnight, often do not complete their metamorphosis. On several occasions trunks were cleared of nymphs near midnight and the cast skins observed the following day. In one test, on May 21, all nymphs were removed from an oak tree to a height of 10 feet at 12:30 a.m. The same morning at 8:30, 107 nymphs were found to have anchored themselves in the interim, of which 73 had been able to extricate themselves. Some of those caught by their shells were still alive. Between 6 p.m. and 12 p.m. on May 21 only four nymphs out of the countless thousands that had crawled up the trunk of a large oak tree appeared unable to emerge. It seems quite possible that moisture or temperature is the factor, as individuals kept in a refrigerator for the purpose of daylight photography of the emergence never were able to leave their shells except when covered with a moist towel, which was removed only at brief intervals.

What factors regulate emergence?—It has been stated in the literature very definitely that climatic factors do not regulate emergence. Three identical wooden shelters 6 by 4 by 1 feet, covered with black paper, were constructed and set in line 18 inches apart. Shelter 1 was heated by a looped cable buried in the soil to a depth of 6 inches, 2 served as a check, while 3 was lighted with two rows of three each of

60-watt frosted bulbs. The heat box was controlled by a thermostat set at 75°. Dirt was piled around the bases of the boxes. The current was turned on April 16 and except for several brief intervals operated continuously until after the last emergence in the boxes. On April 22 thermographs were installed in shelters 1 and 3, that in 1 for soil temperature and that in 3 for air temperature. A summary of emergence in these shelters is presented in table 1.

These experiments show definitely that temperature accelerated development during the month prior to emergence. The heat from the light bulbs appeared to accelerate emergence but light in these experiments did not seem to exert any influence either for or against emergence. The rhythm of emergence after sunset was unbroken. Mercury vapor lights did not attract adults or hasten emergence in limited tests. Box 3 indicates that temperature is responsible, at least in part, for the failure of full-grown nymphs to transform normally. In this shelter on two days the air temperature ran above 100° F, and the final total count showed that 43 out of 163 nymphs died transforming, the heaviest mortality occurring on the two hottest days. The check box was slightly retarded but not sufficiently to appear significant.

The turret remains a mysterious phenomenon. The first turret formation was noticed in the areas near College Park during the first week of April, and by April 18 was well advanced. At this time all burrows observed were within 1 inch of the surface. Turret building in general ended two weeks before the first emergence, almost a month prior to the peak. Emergence takes place through the orifice at or very near the top of the turret. Three turrets were found with the orifices at the base, substantiating the much-attacked illustration of C. V. Riley in 1868. Most of the turrets were 35 to 50 mm. high, the largest measuring 75 mm.

How are turrets formed?—Observations on the method of constructing turrets were difficult because of the fact that most of the construction observed was done in late afternoon and evening and after dark. The nymphs retreat rapidly upon the least disturbance. In one case a nymph was found in late evening to make two trips to the surface before it became too dark to observe. The trips were separated by intervals of 15 minutes. The eyes appeared at the opening, followed by the prothoracic legs and base of the mouth parts. The legs were held very close to the body and the base of the mouth parts was pressed against the opening. A mud pellet, which appeared from between the front legs, looked too soft to remain in place, but after a kneading motion by the legs the pellet of mud was placed around the opening in a ringlike manner and smoothed out with the front legs. This pellet was about 2 to 3 mm. The final pellet closed the orifice like a plug and slight motions of this portion of the turret showed that the nymph was working it into place from within. Light did not disturb turret formation in the boxes. When burrows in the open were covered with flower pots it was found that the building activity commenced much earlier in the day than otherwise.

When freshly built turrets were removed and the burrow beneath examined it was found that there was no excess of moisture in the bottom of the hole, the soil appearing no more damp than surrounding soil at the same depth.

Why does the cicada construct turrets?—Most of the hypotheses proposed to explain the causes of turret formation are based on the factors of moisture, light, heat and soil type. Very extensive observations during the 1936 season showed none of these to be consistent. In the artificial shelters there was no significant difference in the size or number of turrets. Under natural conditions in several scattered locations turrets and open burrows were found to be present in such varying proportions as to preclude any generalization whatever. For example, in certain low, wet areas all burrows were capped with turrets, whereas in other similar areas turrets were practically lacking. In some areas turrets and uncapped burrows were found in almost equal proportion. Turrets were very common in some very dry soils, such as the top of a high mountain near Hancock, Md., where the land breaks into an almost vertical cliff of several hundred feet, yet in other dry soils turrets were completely lacking. One observer found attempts at turret construction in a soil composed almost entirely of sand. Here the nymphs met with failure and attempted to seal the burrows over again, which in some cases they were unable to do. As far as light is concerned turrets were found in full sun, semi-shade, and almost total darkness, while in the same types of habitats they were often completely lacking though there were many uncapped burrows. The influence of the layer of vegetable matter at the surface of the soil was suggested by the fact that in a pine forest which was burnt over after cicada turrets had been constructed it was noted that practically all emergence from the soil took place through turrets. A similar area was experimentally burned previous to the time the turrets were built, and in this area no turrets were constructed though the emergence here was heavy and in the area immediately adjacent turrets were numerous, often being found right up to the burned area. It was also noticed that turrets were not formed in any of the areas under observation in closely clipped lawns or in soil that was practically free from leaves and other debris (except for the case of the sandy soil) though in adjoining shrubbery borders and fields covered with honeysuckle, pine needles, etc., turret formation was heavy. The principal inconsistency here is the fact that uncapped burrows were found along with the turrets in many places where vegetable matter was present. The work done on turret formation does not warrant any generalization.

Why does the cicada sing?—The cicada's song, transmitted over a carbon microphone to a loud speaker in an adjoining room, failed to orient significant numbers of virgin females. A repetition of the experiment during a radio broadcast likewise showed negative results on a cage of females though the sound to the human ear seemed to be the same over the radio as in nature. No answer can be made to the question.

Do certain varieties of plants resist the cicada?—While it is a well-established fact that certain plants are damaged much more than others by the cicada, little is known except in a general way. It was noted that in areas where cicadas were extremely abundant such plants as delphinium, hardy phlox, and the stems of the common *Hemerocallis fulva* were attacked, while in many areas where the insects existed in small numbers only such plants as the oaks, hickory, locust, etc., showed conspicuous signs of oviposition. In one lawn the North American *Azalea*

calendulaceae was severely attacked while three feet away the Japanese *A. mollis* showed no egg punctures though adult females were clustered on both varieties continually during the height of the oviposition period. It was also noticed that *Magnolia soulangeana* was attacked while *M. stellata* and *M. glauca* nearby were absolutely free from injury, though cicadas were clustered on all three varieties. These observations might easily be reversed elsewhere. The most consistent thing about this insect is its apparent inconsistencies.

How long does the cicada live?—The exact length of life of the adults was not determined because of the difficulty of getting them to live in cages. In the laboratory adults were kept in cages on apple branches upon which they fed. The greatest longevity was 23 days. It appears certain that the females live longer than the males, as on May 29 all unparasitized or uninjured dead cicadas collected were males, while on June 2 the dead males outnumbered dead females 9 to 1. Counts on the sex ratio at every period of the emergence showed an even distribution of sexes up to this time.

An occasional male was found with the genitalia cleanly ripped out, and twice females with the male gentialia adhering to their abdomen were collected. Many of the males collected had the genitalia visibly damaged. The damage might be the cause of the earlier death of the males rather than the often given reason that the male of the species is no longer useful for preservation after mating has been accomplished.

Will eggs in dead twigs hatch?—In August examination of eggs in dead twigs both on the trees and those fallen to the ground showed that of 593 eggs examined from various locations and hosts not a single egg was observed to have hatched. Twigs broken from trees and kept in a moist chamber also failed to hatch. One exception was noted in a dry twig found in full sunlight in which all eggs had hatched. It is apparently possible for eggs in dry wood to hatch but it does not appear to occur frequently.

What is the percentage of hatch?—Counts made in August 1936 show the average hatch to be 94.5 per cent.

How many eggs may be laid in a tree?—The enormous number of eggs laid in one tree may be gathered from calculations made from a freshly cut oak tree 33 feet high, with a limb spread of 13 feet, a diameter of 8 inches at a distance of 2½ feet above the base, on which the first limb was 9 feet from the ground. Out of a total of 5505 punctures, the total number of eggs would be 138,175.8, based on the known average of 25.1 eggs per puncture. The possible number of nymphs, based on the average hatch of 94.5 per cent, would be 130,565.4. It is interesting to note that cicada eggs kept in a refrigerator at 32° F for 24 hours, after which the temperature was reduced to 18° for another 24 hours, hatched after a return to normal outdoor temperatures. Percentage counts were not made because of the small number of eggs used in this test.

Does tree growth crush the eggs?—Out of 191 egg pockets dissected in August 1936, 24 pockets had the eggs crushed, a percentage of 14.4.

Which eggs in the pockets hatch first?—It was found that any egg within the pocket might be the first to hatch. Observation was impossible without removal of the wood fibers.

When does hatching occur?—According to the 1936 records in Maryland the main hatching began July 24 and ended August 26. Inasmuch as the peak of the oviposition period began in late May and ended in mid-June it seems that the period of incubation must be shorter than the 10 weeks, often given as the time required. No punctures were marked and watched continuously, so that the exact average incubation was not determined. However, there is possibly a great variation, as one egg puncture was found hatching on July 2, well in advance of any other records available for Maryland.

How do nymphs enter the soil?—The assumption that the nymphs fall from the branches and twigs to the soil was substantiated by actual observation. Tanglefoot bands placed around the main branches and trunks of seven small trees yielded a total of one nymph, showing the improbability of the nymphs crawling down the tree to the soil. At College Park, on August 6, and at Hancock (date undertermined) two observers saw actual hatching and nymphs dropping to the soil from low branches. In several instances the nymph dragged the egg case to the edge of the puncture before finally ridding itself of it and dropping. Immediately upon reaching the soil the young insect began burrowing vigorously. In loose soil the nymph burrowed out of sight in 30 seconds to two minutes. In was definitely ascertained that the young cicada does not require an opening through which to enter fairly loose soil. No observations were made in hard or cracked soil. Nymphs were found at depths of 3 to 4 inches one week after hatching.

A new fungus enemy of the cicada was recovered from live cicada nymphs attempting to emerge but apparently too weak to complete the process. Dead individuals in the soil later were found to be parasitized by the same organism. The fungus, identified as one of the green muscardine fungi, *Metarrhizium anisopliae* Sorokin, plugs the tracheas with its white cottony mycelia. It does not appear to be nearly as abundant as the often reported *Massospora cicadina*.

How can the cicada be reared indoors?—Cicadas may be reared through the last few months in white potatoes, sweet potatoes, apple, turnip, carrot and onion. An apple corer was used to open a tunnel in the vegetables and the tunnel was later plugged with an end of the cut out portion. In the white potato one cicada lived 63 days, and one in the sweet potato 48 days. The other vegetables were less satisfactory. The nymphs did not live long when kept in a steam heated room, but those kept in potatoes in a cool dark basement with a temperature of 55 to 58° F at all times gave the best results. None emerged from the vegetables into adults. One nymph kept in a dampened plaster-of-Paris mold developed into a normal adult.

What is a heavy cicada population?—At Hancock in two heavily infested mountainside orchards various counts were made. Based on the minimum count of 32 nymphs per square foot the population per acre was calculated at 1,403,920. In many areas the count per square foot was much greater.

Will spraying control the cicada?—Without passing on the practical merits of spraying to kill the adult cicada it was found that rotenone alone and with *Penetrol*, used at a rate of 4 pounds of rotenone and one-

half gallon of *Penetrol*, gave 25 per cent kill. *Red Arrow* at a dilution of 1:400 killed 100 per cent of all cicadas hit. Spraying at night is preferable as cicadas fly too actively during the day to permit of success then.—1-8-37.

EASTERN BRANCH

PAPER-READING SESSION, EIGHTH ANNUAL MEETING
New York, N. Y., November 1936

Control of *Rhagoletis pomonella* (Walsh) in Cultivated Blueberry Fields

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Rhagoletis pomonella (Walsh)[2] is a native pest in wild blueberries and huckleberries throughout New Jersey as well as most of the blueberry growing sections in other states. The cultivated fields, although surrounded with wild berries, have been apparently free of this pest for the first 10 to 15 years after planting. Until recently, the crop was small and ripe berries were picked each week and marketed promptly so that there was little chance for the eggs to hatch and larvae to grow to noticeable size. As a rule, all the fruit was picked so that there was no infestation built up in the immediate fields. Harvesting methods became less precise with the increased crops and, during the last few years, there were times when the berries were ripe two weeks before picking. This not only gave the larvae more time to develop in the field but increased the number of wilted and dropped berries that never were removed from the field. Finally, the marketing became less speedy. In 1935, infestations appeared in some of the shipments, and naturally, growers were greatly alarmed at the threat against their industry. The growers' organization agreed to do everything in its power to eliminate the pest, and the station undertook to plan a practical control measure that would be reasonably certain of success. The work started near the close of the 1935 shipping season and recommendations were promised for use in 1936.

Lathrop & Nickels (1932), working in Maine, have shown that, in that state, *Rhagoletis pomonella* (Walsh) begins to emerge just as soon as the first berries ripen; about July 1 in normal seasons. About 2 per cent emerge in the first five days, 90 per cent in the next 15 days, and by August 1, 97 to 99 per cent have emerged. The preoviposition period is 12 to 13 days. The experimental work there indicated that dusting with calcium arsenate was an effective control measure in killing the

[1] Paper of the Journal series, New Jersey Agricultural Experiment Station, Cranberry and Blueberry Substation.

[2] C. H. Curran (1932) has described this form as *Rhagoletis mendax*. As the new name proposed has not as yet come into general use, it was deemed advisable not to change it in this paper.

adults before oviposition. Two applications were recommended, one during the week July 13–20 and a second seven to 10 days later.

The work was exhaustive and particularly helpful to us as it gave the seasonal life cycle and the basic principle of control. It remained for us only to solve the problems of the proper insecticide and the timing of treatments suited to New Jersey conditions. Most of the Maine blueberries are washed and canned so there could be no reasonable objection to an arsenical dust, but the New Jersey fruit is eaten fresh so that the use of poisons would be dangerous. Washing before shipping is impractical, as this process would remove the attractive bloom from the fruit and thereby detract much from its appearance. There was no information available on the variation in time of emergence between the two states. The immediate problems, then, were to find an effective nonpoisonous insecticide to use in place of calcium arsenate and to determine local emergence dates.

Laboratory tests of insecticides.—Two nonpoisonous insecticides were considered, derris (5 per cent rotenone) and pyrethrum (.9 per cent pyrethrins). Flies were obtained in March and April from pupae in an incubator and were dusted with definite quantities of insecticide in a cage of measured size. An attempt was made in this way to determine the more effective dust and to approximate the lethal dose needed in the field.

The cage used was of a type especially designed for laboratory tests of sprays and dusts (Doehlert, 1936). It consisted of a metal-framed cylinder 6 inches in diameter and 5 inches high, one side covered with fine wire netting and the other with pyralin. On top of this was placed a lamp chimney approximately 6 inches in diameter at the top and bottom, $8\frac{1}{2}$ inches in largest diameter and 11 inches high. The complete cage had a capacity of one-third cubic foot. It was transparent and could be ventilated. The dust was applied from below with a gun that would handle small quantities completely with a single blast of air. The cloth top and paper floor were changed after application in order to remove any large particles that may have lodged there. The cage was ventilated gently for the time of exposure. The temperature varied from 65 to 70° F and the humidity was maintained by placing a wet sponge between the fan and the opening into the cage. Doses were measured on analytical balances.

Pyrethrum killed the flies in 20 hours when used at the rate of 90 milligrams per cage. The relative slowness with which it killed, together with the scarcity of flies for experimental work discouraged further work with this material. There is no evidence that it is not effective.

Derris at the rate of 30 milligrams to the cage killed the flies in three and one-half hours and, on further tests with smaller amounts it was found that 5 milligrams to a cage would incapacitate flies within two hours and they would die without regaining motive power. No smaller dosages were tried. Five milligrams to one-third cubic foot would equal $4\frac{1}{3}$ pounds to the acre, treating a space 3 feet high or $8\frac{2}{3}$ pounds treating an area 6 feet high. The treatment finally recommended was 10 pounds to the acre for small plants and 15 pounds for larger plants.

At the time of treatment, air machines, both autogiro and the con-

ventional monoplanes, would be dusting cranberries in the vicinity and would be available to the blueberry growers. The operators of these machines were experienced and were able to apply a light treatment evenly. These machines were recommended and used exclusively. No diluent was used with the dust.

Time of emergence.—Fruit picked for shipment during the last week in July 1935, and later found to be infested with *Rhagoletis pomonella* was used to furnish material for the emergence study. Three bushels were placed into a screen-bottomed tray 6 by 3 feet in size and 4 inches deep. This was placed about 1 inch above the ground near a blueberry bush at the end of a row in a commercial field. The dried-up remains of the berries were removed in September but the tray was kept in place to protect the spot from birds or other animals. On June 5, 1936, the place was covered with a tight cloth cage of the Lathrop & Nickels design from which the flies could be removed easily. The cage was visited daily and the flies were removed and counted.

The emergence record is as follows:

June 15	2	June 23	3
1	1	26	3
18	2	27	2
19	4	28	4
20	1	29	2
21	9	30	3
22	1	July 17	1

The emergence record based on 38 individuals was not, of course, considered accurately indicative of true conditions. This was, however, the only information available and had to be used. When it is plotted on the chart used by Lathrop & Nickels (1932), the remarkable thing about it is that it parallels the 1928 curve. This curve seems to be about the average for Maine for the years 1926–29. The New Jersey emergence was just 21 days earlier than that of Maine. All of this information was not ready for use this year but on June 26 it was assumed that the rapid increase of emergence started June 21 and recommendations were given to dust commercially on June 30–July 2 and again 10 days later.

Commercial results.—Commerical treatments were made on 225 acres which represents the plantings of 10 different growers. Some of these used a monoplane and some used an autogiro. There was no difficulty in regulating the dosage within set limits of 10 to 15 pounds per acre.

Two small cages, 4 by 10 by 2 inches, of folded-wire mosquito screening, were used to hold flies in the center of large bushes in fields that were being dusted by autogiro. Six flies were used in a cage. All were dead within two hours after treatment.

Two bushes were completely screened with 16-mesh wire netting, one having a cloth floor and the other a wooden floor with a cotton plug around the stems of the bush. In the first instance 51 flies were placed in the cage 15 hours before treatment. After the treatment the bush was examined carefully and no live flies could be found. However, only 34 dead flies were found. In the second instance, 23 flies were placed in the cage before treatment and again no survivors were found. This time only 14 dead flies could be found. The search was thought to be reasonably

careful but it was evident from the bodies found that this insect crowds into tight places when dying. It is much more likely that the dead flies were missed than that live flies escaped from the cages. The two caged bushes were dusted at the rate of 20 pounds of derris to the acre as the grower in this case was attempting also to kill insects other than *Rhagoletis pomonella*. No live flies were found in any of the dusted fields 24 hours after the treatment.

About July 12, two large larvae were located in berries from dusted fields. From their size we estimated that the eggs from which they came were laid before the first treatment. Late in July, pint samples were taken from each of 28 treated fields throughout the state and examined. Altogether only two larvae were found. In the sample from one undusted field there were 30 larvae, in another 19, and in another 1.

Conclusion.—Adults of *Rhagoletis pomonella* (Walsh) can be killed in cultivated blueberry plantations by dusting from an airplane or autogiro, with 10 to 15 pounds of derris dust (5 per cent rotenone) to the acre.

The time of treatments in New Jersey is approximately June 27–30 and July 7–10.—2-10-37.

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Reaction of Corn Ear Worm Moth and Other Insects to Light Traps

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During a study of possible methods for controlling the corn ear worm, *Heliothis obsoleta* Fabr., in sweet-corn fields on western Long Island, electrocuting light traps were tested during the seasons of 1934, 1935 and 1936. These tests were begun with the knowledge that the number of corn ear worm eggs laid per female moth probably averages a thousand and it was sought to determine whether a sufficient number of moths could be attracted and destroyed by the traps materially to reduce the larval infestations in adjacent cornfields. As the work progressed it was found that certain other insects became attracted to the light traps and, of these, observations on catches of moths of the European corn borer, *Pyrausta nubilalis* Hubner, and adults of the Asiatic garden beetle, *Autoserica castanea* Arrow, are reported.

The data reported were obtained during the season of 1936 and are supported by preliminary work done with certain phases of the problem

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during the two preceding seasons. The tests were made in cornfields near Roslyn, N. Y., 20 miles east of New York City.

Materials and methods.—The electrocuting light traps used were manufactured by the Folmer Electracide Corporation of Rochester, N. Y., and consisted of a light source surrounded by a series of alternating grids charged, by means of a transformer, with electricity of a high voltage and a low amperage. Insects attracted to a light source were electrocuted upon contact with two adjacent grids. The dead insects accumulated in a panlike receptacle made of screen wire and attached just below the grids. Description of the light sources used in the traps is given in table 1. The traps were hung from specially built standards placed in the cornfields in such a manner that the light sources were located at the approximate level of the corn tassels. Three cornfields were used for the tests during the 1936 season and the traps remained in each field from the time the first silks appeared until harvest except in the earliest planting, where the traps were installed prior to silking. The exact arrangement of the traps varied with the available corn plantings although it was possible in practically every instance to locate the traps 50 feet apart and at least 30 feet within the limits of a cornfield. The 60-watt mercury vapor light trap was located as far as possible from the other traps in the same cornfield. The 25-watt and 60-watt mercury vapor light traps were operated nightly from June 20 until September 21, 1936 while the tungsten light traps were used from August 8 to September 1. The traps were controlled by means of a *Sangamo* automatic time switch which turned the current on at dusk and off at 8 a.m. It was originally planned to have the current shut off at daybreak but it was found the unless the current remained on until the time the daily records were taken an error was introduced by the feeding of birds

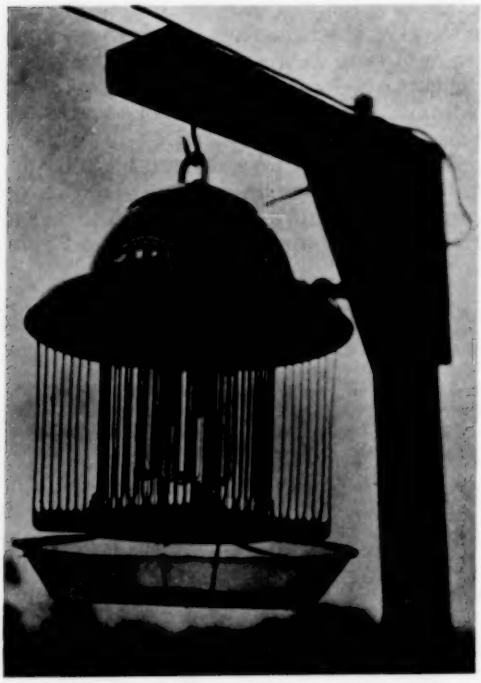

Fig. 1.—The 60-watt mercury vapor electrocuting light trap used during the summer of 1936. The light source was in the form of a coiled glass tube with seven turns. The four 25-watt mercury vapor traps were similar in appearance except that the outward-projecting baffle grids were lacking and that the light sources were in the form of simple, U-shaped glass tubes.

at the receptables containing the electrocuted insects. The records of the nightly catches were tabulated each morning in the field on mimeographed forms. Two possible sources of minor error in the records were caused by certain small insects being burned beyond recognition during electrocution and by certain moths that escaped after being stunned, but not electrocuted. In both cases the numbers of individuals involved were relatively small and the totals were probably not materially affected. The mean night temperatures were calculated from hygrothermograph records of the period each night between 7 p.m. and 5 a.m., eastern daylight saving time.

Influence of night temperatures.—The relationship between mean night temperatures and the total numbers of corn ear worm moths, European corn borer moths and Asiatic garden beetles caught each

Table 1.—Description of the three types of light traps used during 1936.*

No. Traps Used	Relative Cost	Nature of Light Source	Watts	Candle-power	Relative Energy Transmission† in Angström Units		
					3000–4000	4000–5000	3000–7000
4	1	tungsten‡	75	69.1	.0	.4	3.82
4	1.3	Hg vapor	25	1.35	.21	.21	1.2
1	2	Hg vapor	60	23.3	4.74	5.92	44.4

* Analysis of the light sources was made by E. M. Lowry and L. A. Jones of the Eastman Kodak Company in a report made available through the courtesy of the Folmer Electracide Corporation.

† The values given for the relative amounts of energy transmitted are stated in percentages of the energy transmitted by a 75-watt tungsten lamp in the absence of filters. Because of differences in the filters used to obtain this data the values given are not comparable horizontally.

‡ The traps with the tungsten light sources were identical with those used and illustrated by Hervey & Palm (1935).

night is shown in fig. 2,[2] which is based on records obtained during the entire season from the four 25-watt mercury vapor light traps. It will be noticed that the numbers of insects caught are appreciably influenced by night temperatures, particularly when the latter reach the vicinity of 60° or lower. This is in accordance with the observations of Hervey & Palm (1935) on the European corn borer and of Herms & Ellsworth (1935) on the grape leafhopper. A similar relationship between temperature and insect abundance was observed during the season of 1935 when a series of incandescent light traps was operated for nearly three months although, as indicated below, the numbers of insects caught were also affected by the nature of the light source.

Seasonal variations in catches.—In fig. 2 a seasonal variation in the numbers of insects caught is noticed quite apart from the variation due to temperature effects. A similar variation was also noted during the summer of 1935. The greatest numbers of Asiatic garden beetles appeared in the light traps during late July and August at a time when the adults of this species are normally most abundant. It is not known to what extent more individuals would have been attracted to similar traps in nearby situations other than cornfields. Two broods of the European corn borer occur each season in the area where the light traps were operated. In fig. 2 the peak of European corn borer moth abundance indicated during late July and early August was produced by adults resulting from

[2] The daily records upon which figs. 2 and 3 are based are omitted because of space limitations. Further information will be gladly furnished by the senior author.

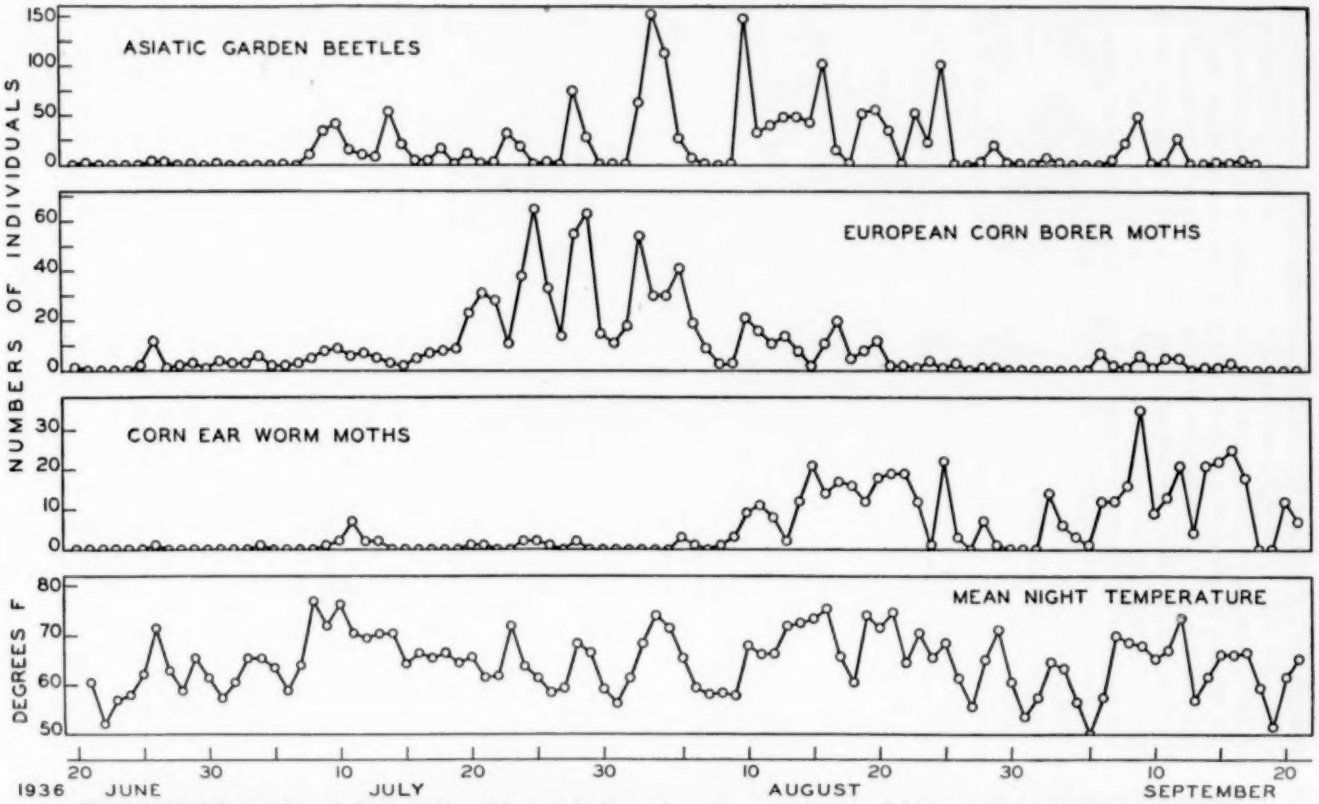

Fig. 2.—Nightly catches of three species of insects in four 25-watt mercury vapor light traps during the summer of 1936.

the first generation of larvae. These larvae produced severe infestations in Long Island cornfields during the early part of the 1936 season. The light traps were not operated early enough to attract appreciable numbers of the generation of European corn borer moths which developed from overwintering larvae. The corn ear worm usually produces a light first brood of larvae on Long Island during July followed by a second brood and a partial third brood during the period between mid-August and the end of the growing season. In 1936 the first brood was extremely light and no appreciable injury to corn was noticed until after mid-August. In fig. 2 this situation is reflected in the comparatively small numbers of corn ear worm moths caught during the early part of the season. In addition to the insects represented in fig. 2 a perceptible

Table 2.—Average numbers of insects attracted per trap per night by three types of electrocuting light traps operated during the period from August 8 to September 1, 1936.

	75-WATT TUNGSTEN			25-WATT Hg VAPOR			60-WATT Hg VAPOR		
	Males	Females	Total	Males	Females	Total	Males	Females	Total
Corn ear worm moths	.45	.28	.73	1.94	.35	2.29	3.4	.88	4.28
European corn borer moths	1.13	1.07	2.2	.64	.85	1.49	1.12	1.32	2.44
Asiatic garden beetles			18.7			8.25			21.4
Miscellaneous moths of all species			31.33			23.36			49.56

number of moths of the eastern tent caterpillar, *Malacosoma americana* Fabr., were attracted to the light traps during late June and early July 1936 with the peak of abundance occurring on the night of June 27.

Comparative test of light sources.—During the period between August 8 and September 1, 1936, the two types of mercury vapor light traps and the tungsten light traps were operated in different sections of the same cornfield for purposes of comparison. The average numbers of insects caught per night in each of the three types of traps are shown in fig. 3. The mercury vapor traps consistently attracted more corn ear worm moths than the tungsten traps although the differences between the light sources were less striking when the catches of European corn borer moths were considered. The 25-watt mercury vapor traps were less effective than the other types of light sources in attracting asiatic garden beetles. The 60-watt mercury vapor trap appeared to be slightly more effective than the tungsten traps although it should be remembered that but one trap of the former type was used and that the results obtained from it should be considered only as an indication of its effectiveness. In a study of the attraction of asiatic garden beetles to light traps (of another sort) Hallock (1936) states that a G-5 100-watt Westinghouse mercury vapor lamp was more effective than a number of other light sources tested and that this species is most attracted by the shorter waves of light from near the violet end of the spectrum. His results are not strictly comparable to those reported herewith since different light sources were used and his tests were not made in cornfields. It appears, however, that results more comparable to those of Hallock might have been obtained had a more powerful mercury vapor light source been used.

In the daily records of insects caught the male and female moths of the

Fig. 2.—Nightly catches of three species of insects in four 25-watt mercury vapor light traps during the summer of 1936. JUNE

corn ear worm and the European corn borer were tabulated separately. The results for the period between August 8 and September 1, 1936, are indicated in table 2 together with a summary of the numbers of asiatic garden beetles and miscellaneous moths of all species attracted to each of the three types of light sources. Both sexes of the European corn borer appeared to be attracted approximately equally to the three types of light sources although the 25-watt mercury vapor traps attracted a smaller total number of moths than did the other two types of traps. The results obtained from the 60-watt mercury vapor light trap are not to be taken conclusively although they do offer an indication that similar and more powerful light sources may be more effective than those of the

Table 3.—Effect of location and quality of light sources on corn ear worm infestations in adjacent areas.

Relation to Lighted Row		Nature of Light Source					
Distance in 3-foot Rows	Direction*	25-watt Hg Vapor		60-watt Hg Vapor		75-watt Tungsten	
		no. ears	*per cent infestation*	*no. ears*	*per cent infestation*	*no. ears*	*per cent infestation*
10	left	71	28.2	60	33.3	75	28.
5	left	79	25.3	80	26.3	76	42.1
3	left	95	36.8	67	31.3	75	45.3
1	left	99	32.3	72	44.4	74	31.4
1	right	99	30.3	76	42.1	76	36.8
3	right	121	26.4	73	37.	76	31.6
5	right	112	38.4	50	34.	76	44.7
10	right	85	36.5	60	25.	76	31.6

* The word "left" indicates the direction *west* in the case of both types of mercury vapor light traps. "Left" indicates *north* in the case of the tungsten light traps.

tungsten type. The two types of mercury vapor traps attracted more corn ear worm moths of both sexes than did the tungsten traps although more males were obtained than females. The relative proportions of male and female corn ear worm moths actually present in the residual field population of the experimental area was not determined although laboratory and field observations in Texas by Quaintance & Brues (1905) indicated a slight preponderance of females over males. It may be questioned whether the light traps described in this paper were fully effective in attracting egg-laying female moths of the corn ear worm.

In preliminary tests Ditman (1933) indicated that corn ear worm moths responded most readily to light from the blue end of the spectrum. Other workers (Collins & Machado, 1935; Ditman & Cory, 1933; Hallock, 1936; Herms & Ellsworth, 1935; Peterson & Haeussler, 1928) have reported similar observations in tests with certain other insects, including the codling moth, oriental fruit moth, asiatic garden beetle and grape leafhopper.

Effects of light traps on corn ear worm infestations.—Slight infestations during the early part of the season and a hurricane in September 1936 interferred with the satisfactory determination of the effects of the light traps on corn ear worm infestations. It was possible, however, to make a harvest infestation count during the last week in August in the cornfield in which the comparative test of the three types of light sources was made. In this cornfield, practically no ear worm infestation was present when the silks started to appear at the end of the first week in August. The corn was a Golden Bantam hybrid planted in rows 3 feet apart.

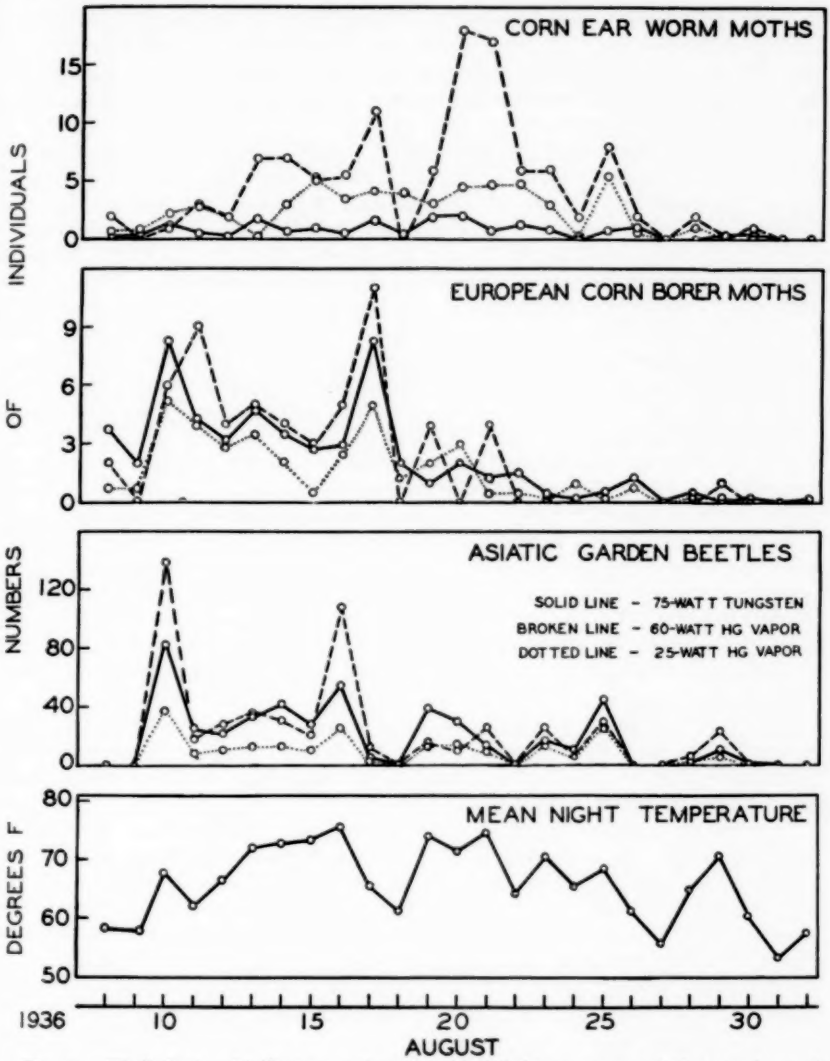

Fig. 3.—The relationship between three kinds of light sources and the numbers of insects caught per trap per night in electrocuting light traps.

The three types of light traps were placed in different sections of the field, the 25-watt mercury vapor traps and the 75-watt tungsten traps being located 50 feet apart in single rows located at right angles to each other. The 60-watt mercury vapor trap was placed in an opposite corner of the field. The infestation counts were made just prior to picking and included an examination of the uppermost ear of each normal corn plant in a 300-foot section of rows 1, 3, 5 and 10 on each side of the rows con-

taining the 25-watt mercury and the 75-watt tungsten traps. In the area surrounding the 60-watt mercury vapor trap 100-foot sections of adjacent rows were counted in such a manner that the light trap was in the approximate center of the area examined. The results of these observations are shown in table 3.

The results presented do not indicate any appreciable reduction in corn ear worm infestations because of any of the light traps used. Certainly no practical degree of control was obtained. It appears that in view of the high fecundity of the female moths the light sources used were ineffective from a practical viewpoint although much interesting technical information was obtained. Herms & Ellsworth (1935) state that " . . . insect electrocutors proved of great value in the control of such insects as the corn ear worm . . ." Their experimental conditions are not described sufficiently to permit a comparison with the conditions under which the present work was conducted. It may be noted, however, that at no time during three seasons' investigations of electrocuting traps for controlling the corn ear worm on western Long Island were the traps used sufficiently satisfactory from a practical point of view to warrant a similarly favorable statement.

In tests of 75-watt tungsten light traps against the European corn borer moths, Hervey & Palm (1935) state that the larval infestations were invariably higher in the areas surrounding the traps. European corn borer data were not taken during the infestation counts reported in this paper but no consistently similar tendency was observed in the corn ear worm data presented above. Slight trends in this direction are noted in certain instances but the uniformity and magnitude of the differences do not warrant any generalizations.

It remains to be determined whether a more effective light source for attracting female moths of the corn ear worm can be discovered. The practical value of this type of control of the corn ear worm appears to be contingent upon such a discovery.

Summary.—Three types of light sources in electrocuting traps were tested against female moths of the corn ear worm in cornfields on western Long Island during 1936 in attempts to reduce larval infestations in sweet corn. The numbers of moths caught were directly influenced by mean night temperatures. A seasonal variation in numbers of moths caught was observed which corresponded with expected periods of moth abundance. Two types of mercury vapor light sources each attracted more corn ear worm moths than did a 75-watt tungsten light source although fewer females were caught than males. It may be questioned whether any of the traps used were fully effective in attracting female moths of the corn ear worm. No appreciable reduction in larval infestations resulted from any of the traps used. Incidental observations are reported on the reaction of asiatic garden beetles and moths of the European corn borer to the light traps.—12-14-36.

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Reactions of Aphids to Colored Insecticides

Joseph B. Moore, *New York State Agricultural Experiment Station*,[1] *Geneva*

Aphids tend to increase in numbers on potatoes sprayed with Bordeaux. In a previous paper (Moore, 1935), it was demonstrated that the intensity of light reflected from a potato leaf surface sprayed with

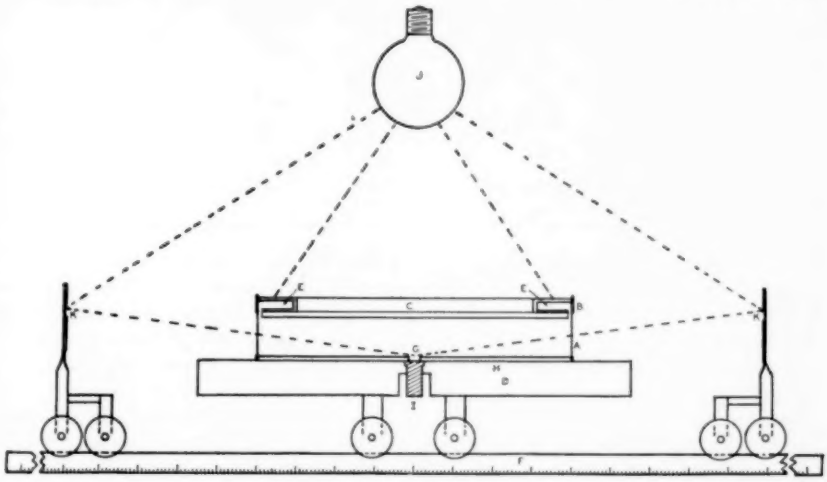

Fig. 1.—Apparatus for studies of aphid responses to variable light intensities.

Bordeaux was greater than that reflected from the unsprayed leaf surface. Therefore, it appeared to be of interest to determine whether the insect responses would follow the inverse square law of light intensities and thus show that light intensity is the primary factor in attracting the aphids to the sprayed leaf surfaces. The apparatus shown in fig. 1 was used in a series of experiments to test the phototropic responses of the

[1] Approved by the Director of the New York State Agricultural Experiment Station for publication as Journal paper 168, Nov. 9, 1936. The laboratory work was done under direction of Dr. G. F. MacLeod, Cornell University.

aphids to sprayed and unsprayed leaf surfaces at variable measured distances from a known light source.

The aphid response box was a wooden box open at both ends. The open ends were covered with Cellophane, fig. 1, A, held in place with metal frames, B. The bottom of the box was a piece of plate glass, H, with a hole, G, drilled in the center. The top was covered with asbestos, C. The box was 8 inches long, $1\frac{3}{4}$ inches wide and 1 inch deep. A screw cap of a shell vial was punctured and cemented over the hole in the glass bottom of the box. The vials were used as containers for the aphids, and were painted black, I. They could easily be changed without jarring the apparatus. The response box was placed on a board painted black, D, which was centered on a photometry bench, F, in place of the photometer head. Directly opposite and at least 19.5 cm. from one end of the

Table 1.—Comparative numbers of aphids responding to light reflected from sprayed and unsprayed potato leaves at variable distances from the source.

Distance of Sprayed Leaves from Light Source	Relative Light Intensities	Number Aphids Responding to		Percentage Difference between Sprayed and Unsprayed Leaf
Cm.		Unsprayed Leaf	Sprayed Leaf	
19.5	1	229	371	62
21	.444	243	357	46.92
22	.160	268	332	23.98
22.5	.111	270	330	22.22
24.5	.040	301	299	−.66
25.5	.028	310	290	−6.45

Difference to be significant, 3.363

box was held a sprayed potato leaf, while at the other end was an unsprayed leaf with the same area exposed. These leaves could be moved independently either toward or away from the ends of the box while the latter remained fixed. A 1000-watt tungsten-filled Mazda lamp, J, was suspended directly above the center of the box and was adjusted in height, angle of incidence and current to deliver an equal intensity of illumination at each exposed leaf surface. As the light from the lamp struck the leaf surfaces, K, it was reflected through the Cellophane into the response box and was focused on the hole in the glass floor of the box. Glass cells, E, were located above the Cellophane at the ends of the box to trap the insects for counting after they had responded to the light. The construction of this box was based on the supposition that aphids, responding negatively to gravity, would come up out of the container through the hole in the glass bottom of the box. They would then be in the exact center of the box and in the path of the parallel rays reflected from both leaves. They could take their choice as to which direction they would move and go to the Cellophane. Here again they would oppose gravity and pass up into the glass cells where they would remain in response to the direct rays of the light bulb. It would then be a simple matter to count them either in the cells or as they entered the cells.

A series of tests using 30 aphids, *Myzus persicae* Sulz., both winged and wingless adult females, reared on potato plants in the greenhouse, was conducted with this apparatus. Each run was repeated 20 times at different positions of the sprayed leaves on the photometry bench. Thirty new aphids were used for each test. There were six positions of the sprayed leaf in this experiment, while the unsprayed was held continuously at 19.5 cm. from the center of the box. In the first test, the sprayed leaf was 19.5 cm. from the center of the box. In the next it was moved out to 21 cm., and in succeeding runs the positions of the sprayed leaf were 22, 22.5, 24.5 and 25.5 cm. respectively. Results appear in table 1.

It is apparent from these data that larger numbers of the insects tested were consistently attracted to the sprayed potato leaf as compared with the unsprayed leaf. Apparently this response was due to the increased intensity of light reflected from the sprayed leaf surfaces. Moreover, as this intensity was decreased by moving the sprayed leaf to increasingly greater distances from the light source, the differences in numbers of aphids attracted to the sprayed and unsprayed leaves decreased in an inverse proportion to the distance, fig. 2. It was interesting to note that the aphids could not distinguish differences in the intensities of light reflected from the two leaves when the sprayed leaf was 5 cm. farther than the unsprayed leaf from the center of the box; while, when a photometer head was substituted for the aphid response box, the sprayed leaf had to be moved out an additional 5 cm. before the intensities were equal to the human eye. Assuming that the insects' vision is somewhat poorer than that of persons, as Lutz (1924) has pointed out, it would seem possible that aphids could not distinguish differences of intensity used at a greater distance than 5 cm. under the conditions of these experiments.

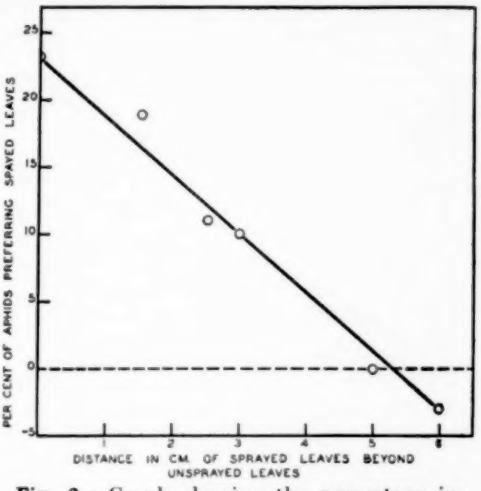

Fig. 2.—Graph showing the percentage increase of aphids responding in relation to the decrease in distance of the sprayed leaf from the light source.

Previous tests (Moore, 1935) with colored sprays on potatoes showed that dyeing the Bordeaux green decreased the number of aphids per plant. The aphids on potatoes in western New York are not numerous enough to be of economic importance. However, the cabbage aphid, *Brevicoryne brassicae* L., is quite abundant. It has been observed that cabbage dusted with lead arsenate–lime has larger numbers of aphids than untreated cabbage. An experiment was conducted this past sum-

mer, using colored dusts on cabbage, to determine their effect on aphid populations. Gasoline-soluble dyes, prepared by the Calco Chemical Co., Inc., Bound Brook, N. J., were used to dye lead arsenate–lime dust. Three colors were used in these experiments: green, which faded in direct sunlight within an hour or so after application; red, which faded in 24 hours, and a black which was made up with 300-mesh charcoal

Table 2.—Numbers of aphid colonies per plant on cabbage dusted with various colored dusts.

Replications	White	Green	Red	Check	Black
1	266	243	153	91	120
2	211	167	143	195	63
3	176	213	211	143	92
Total	*653*	*623*	*507*	*429*	*275*

Difference to be significant, 66.861

as a diluent in place of the lime. The regular lead arsenate–lime dust was used as a white check on the dusted plots. There was also an untreated plot used as a check. The plots were four rows wide and 10 plants long. Each treatment was replicated three times at random. The treatments were applied weekly for a period of five weeks, commencing when the first aphids were noticed in the field. Counts of the number of aphid colonies per plant were made six weeks after the first application. The results appear in table 2.

It can be seen from the table that the red and the black have significantly less aphids per plant than the white, or the green which was for all practical purposes white. Another count was made one month after the treatments had ceased. The heads of cabbage, which were infested sufficiently to ruin the quality of the head, thus rendering it unmarketable, were counted in the two center rows of each plot. The results appear in table 3.

Table 3.—Number of plants sufficiently infested to render head unmarketable.

Replications	White	Green	Red	Check	Black
1	15	10	6	7	6
2	5	11	8	8	5
3	8	7	7	5	3
Total	*28*	*28*	*21*	*20*	*14*

Difference to be significant, 4.41

Summary.—It was found that aphids, *Myzus persicae* Sulz., are attracted to potato plants when they are sprayed with Bordeaux because of the increased intensity of light reflected from the sprayed surfaces. The insects appear to follow the inverse-square law of light intensities, thus showing that light intensity is the primary factor involved in attracting the aphids to the sprayed surfaces. It was also found that infestations of the cabbage aphid, *Brevicoryne brassicae* L., on dusted plots could be reduced below those on untreated plots by dyeing the

dusts used. Black dust was the most effective in reducing the infestation. These experiments suggest that present dusting and spraying practices on crops infested with aphids may be profitably modified by the use of dyed materials to produce a reduction in the intensity of light reflected from the treated surfaces.—1-25-37.

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Some Facts Underlying the Attraction of Mosquitoes to Sources of Radiant Energy

Thomas J. Headlee, *New Jersey Agricultural Experiment Station,*[1] *New Brunswick*

Curves representing reaction of insects to sources of radiant energy are not straight lines. At the lower end of the curve the intensity of the energy becomes so small that the insect no longer reacts to it. At the upper end of the curve the intensity of the energy becomes so great that the insect is not only not attracted but actually is repelled. The nature of the reaction will vary primarily with the stage and species of insect concerned and with the type of source of radiant energy used.

Two factors in the type of source are important. The first is frequency and the second is intensity. It appears to be possible to make any frequency, which at certain intensities is normally attractive, highly repellent by increasing the intensity beyond a certain point. There have been many studies of the reaction of insects to various frequencies but little attention has been given to the intensity factor; primarily because the readily available discontinuous sources of radiant energy are not subject to much variation in intensity and apparatus for the measurement of intensity is comparatively unusual and requires a high degree of skill for its successful use.

In earlier studies the writer (Headlee, 1932) tried to cover the intensity factor by using the rated wattage of the energy source. Unfortunately, the rated wattage does not afford an accurate measurement of the intensity of the energy emitted from the source. Having on hand a piece of apparatus for the measurement of total energy emitted per square centimeter of surface at a measure distance from the source, the writer decided to find out what relationship existed between certain sources of radiant energy known to be attractive to mosquitoes and the number of mosquitoes caught under the same set of environmental conditions.

Methods employed.—Four of the New Jersey mosquito traps were

[1] Paper of the Journal series, New Jersey Agricultural Experiment Station, Department of Entomology.

set up. The sources of radiant energy employed were a 25-watt white-frosted bulb, giving a white light, under the hood of trap 21; a tube filled with Neon gas giving a red light, in trap 2; a tube filled with mercury vapor and stained so as to give a green-yellow light, in trap 3; and a tube filled with mercury argon vapor and unstained, giving a blue light, in trap 4. The vapor-filled tubes when subjected to high voltage blazed with light running through red, green-yellow and blue.

Table 1.—Mosquitoes caught in four light traps, second run.

Period	Trap 21	Trap 2	Trap 3	Trap 4
July 16 to August 15, 1935	1621	1096	582	599
Equalized for location	1	.676	.359	.369

Table 2.—Mosquitoes caught in four light traps, first run.

Period	Trap 21	Trap 2	Trap 3	Trap 4
June 22 to July 15, 1935	980	264	90	190
Equalized for location	980	662	351	361

These traps were placed in a row about 50 feet apart and the lead wires were so arranged in length that the voltage delivered to the pieces of apparatus was essentially the same. Each day, beginning June 22 and ending July 15, 1935, the mosquito catch was removed, taken to the laboratory and identified. On July 16, 1935, all sources of radiant energy were replaced with 25-watt white-frosted bulbs and the traps were run in this condition until August 15. The purpose of the first run, namely from June 22 to July 15, was to obtain a figure on the relative catching ability of these radiant energy sources as measured in terms of mosquitoes caught by the traps which they served. The purpose of the run of the same traps in the same location from July 16 to August 15 inclusive was to evaluate differences in trap location. There seemed to be no other way of eliminating the variable of trap location.

Thus we see that the same pieces of apparatus were employed throughout the experiment, the variable of the trap location was evaluated and the resultant collection of mosquitoes should vary solely in relation to the sources of radiant energy.

Table 1 sets forth the collection study from July 16 to August 15 inclusive.

Table 3.—Energy received per square centimeter at 10 inches from the source.

Color	Spectrum—Angström Units	Total Energy Received, Microwatts
Geeen-yellow	5461, 5790 mercury lines	15.9
Blue	4047, 4359–5461 mercury lines	18.8
Red	5804–7174 neon lines	49.7
White	4000–8000 and beyond into infra-red with peak beyond 8000	760.9

If we take the total catch in trap 21, 1621 female mosquitoes, and let that number represent unity, we can then figure that trap 21 equals 1, trap 2 equals .676, trap 3 equals .359 and trap 4 equals .369.

Table 2 shows the actual collection of mosquitoes in each of the four traps from June 22 to July 15 inclusive.

Equalization for location in the table 2 is accomplished in traps 2, 3 and 4 by multiplying 980 by the equalization fractions set forth in table 1.

In table 3 is set forth the color, the spectrum covered and the total energy given out to 1 square centimeter of surface at a distance of 10 inches from the energy source.

Table 4 sets forth the relation of the mosquito catch to energy units. The number of mosquitoes caught per microwatt of energy in white light has been determined by dividing the number of microwatts emitted on 1 square centimeter of surface 10 inches from the source into the number of insects that should have been caught under white light conditions in each trap during the period from June 22 to July 15 when the various sources of radiant energy were actually running. The number of female mosquitoes caught per microwatt in the green-yellow, red and blue were determined by dividing the number of microwatts of energy

Table 4.—Relation of mosquito catch to energy units.

Color	Mosquito Catch per Microwatt	
	White Source	Colored Source
Red	.87	5.31
Green-yellow	.46	5.66
Blue	.47	10.10

Table 5.—Relative attractant power of different energy sources.

Color	Attraction Power*
Red	5.31/.87= 6.1
Green-yellow	5.66/.46=12.3
Blue	10.10/.47=21.5

* The terms of the number of times the attraction power of white light.

striking on 1 square centimeter of surface 10 inches from the source into the number of insects that were actually caught from June 22 to July 15.

Table 5 sets forth the relative attractant power of different energy sources and the figures are obtained by dividing the number of female mosquitoes per microwatt that would have been taken under white light conditions into the number of mosquitoes caught per microwatt of energy from colored sources in the same trap.

This table shows that the attration power of the red light as measured in number of mosquitoes caught per microwatt is 6.1 times the number that would have been taken per microwatt in white light in trap 2; that the number of mosquitoes taken per microwatt in green-yellow is 12.3 times as many as would have been taken per microwatt with white light in trap 3; and that the number of mosquitoes taken per microwatt in blue light is 21.5 times as great as would have been taken per microwatt in white light in trap 4.

Through his previous work the writer (Headlee, 1932) is convinced that the 25-watt white-frosted bulb does not produce an intensity even approaching that point on the curve of reaction where attraction turns to repellency. He has, however, no means of knowing where on the intensity curve of attraction the intensities emitted from the source of red, green-yellow and blue fall. It is entirely possible that if any one or all of these colored sources were to emit as high a degree of total energy as the 25-watt white-frosted bulb the intensity might approach or be

in that portion of the curve where attraction turns to repellency.—1-19-37.

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Control of the Pavement Ant Attacking Eggplants

HARRY G. WALKER and LAUREN D. ANDERSON,[1] *Virginia Truck Experiment Station, Norfolk*

The pavement ant, *Tetramorium caespitum* L., has seriously injured many fields of eggplants during the last few years in the Norfolk, Va., area. A survey of eggplant fields in this area in the spring of 1936 showed that practically all were infested, and from about 5 to more than 50 per cent of the plants were attacked. The ants feed almost entirely below ground, barking and hollowing out the main tap root and eating the side roots, so that many of the infested plants soon die or are so seriously injured that they fail to produce a crop. The ants attack the plants soon after they are set in the field, about May 1. Most of the damage is done during May as the majority of ants cease feeding on eggplants by the fifth to the tenth of June.

For some unknown reason the ants refused to feed on the poison bran bait which L. B. Smith (1915) and others have recommended for their control. In addition to the poison bran bait, a brown sugar–Paris green (16:1) bait, a carbon disulfide emulsion, and a derris spray applied around the base of infested plants were tried in 1935 with negative results. The ants appeared to be as numerous after the treatments as before and no dead ants could be found.

When the ants appeared in very destructive numbers again in 1936, each of the following materials was tested on five heavily infested and five uninfested plants to determine what effect it might have on the plants as well as on the ants. Small depressions were made about the base of the plant and the material was applied and covered with enough soil to fill the depression. Due to the fact that it was practically impossible to make accurate counts of ants in the soil, no attempt was made to make actual counts of living or dead ants.

Corrosive sublimate was used with water at dilutions of 1:500, 1:1000, and 1:2000. The 1:500 and 1:1000 dilutions killed even the healthy plants but none of the dilutions had any apparent effect on the ants, as they continued to be actively present in large numbers.

Derris Fumigant Powder, containing 5 per cent rotenone, killed a few of the ants and appeared to have a slight temporary repellent action, but the ants soon returned and eventually killed two of the plants.

[1] The authors wish to express their appreciation to Dr. H. H. Zimmerley and H. Marshall Clark for suggestions and help in carrying out the work and to Selby Hawkins and Joe Lambert who furnished the field and cooperated in the work.

Finely ground derris powder was used undiluted as a dust containing 5 per cent rotenone, and diluted with both sulfur and talc to make dusts each containing 1 per cent rotenone, and with finely ground tobacco dust to make a dust containing .75 per cent rotenone. None of these materials had any noticeable effect on either the ants or the plants, the ants continuing to feed on the eggplants in the presence of the derris.

A 1.5 per cent solution of *Creolol*, a tar acid oil emulsion with a phenol coefficient of 2+, gave good control of the ants but also injured the plants.

Soil Fumigant, a proprietary mixture containing 66.66 per cent carbon disulfide and other ingredients, was used at the rate of 1:100 and 1:200. The 1:100 dilution injured the plants and neither dilution had any noticeable effect on the ants.

Both *Cyanogas-A-Dust*, containing not less than 40 per cent nor more than 50 per cent calcium cyanide and not more than 60 per cent inert ingredients, and a mixture containing 75 per cent ethylene dichloride and 25 per cent carbon tetrachloride killed the plants.

A 3 per cent nicotine dust did not kill either the plants or the ants.

The heavily infested plants treated with water, and others left untreated as checks, were killed or seriously injured by the ants, while the noninfested plants continued to grow in a normal manner.

Halowax, a chlorinated naphthalene product, used at a dilution of 1:200, appeared to give very good control as no ants could be found around the treated plants three days after treatment, but they were becoming reinfested after a period of two weeks.

Loro, a thiocyanate, at a dilution of 1:200 gave fairly good control since dead ants were found around some of the plants, and only a very few live ants were found after a period of two weeks. This material did not have any noticeable effect upon the eggplants.

Naphthalene flakes killed many if not all of the ants around the infested plants and seemed to give good lasting protection without apparent injury to the plants 10 days after treatment.

Ants continued to feed on and kill eggplants around which fish scrap and sardine meal had been broadcast.

As a result of these tests, an experiment was started on May 27 to determine the best method of applying naphthalene flakes for the control of the pavement ant. The tests consisted of treating single row plats of about 85 plants, replicated four times, with one tablespoonful of flake naphthalene to each plant, applied in each of the following ways: (1) *buried* in a small hole about 3 inches deep by the side of the plants; (2) *covered* by placing it on top of the ground around the base of the plant and covering it with soil by means of a cultivator; (3) *uncovered* by placing around the base of the plant and leaving it exposed to the air. An untreated check plat was included in each replication. From 10 to 15 per cent of the plants were dead when these treatments were started and about 25 to 30 per cent were severely injured.

In applying the naphthalene it was noted that the ants became very much activated at first, running wildly about, and then dying within 10 to 15 minutes if they were unable to escape its presence.

Examination of the infested plants soon after treatment showed that

practically 100 per cent of the ants were killed or repelled where the naphthalene was buried. A large percentage of the ants died, left the plants, or crawled deep in the ground below the naphthalene where it was covered with a cultivator. Even placing the naphthalene on the surface of the ground appeared to have considerable repellent effect. However, the experiment was started too late for the benefits of controlling the ants to be shown in the crop yield, because the ants stopped feeding on all of the plants soon after the treatments were applied. A few of the injured plants in the treated and untreated plats died after this experiment was started but most of them had begun to grow and put out new roots and leaves by June 15.

Even though the practical value of controlling the ants could not be determined by crop yields, the effect of the naphthalene on plant growth could be noted. Frequent observations were made on the rate of growth of the plants in the different plats and records were taken on the weight and number of fruit harvested from each plat. Early in the season no difference in the rate of growth was noticeable but as the season advanced a slight difference began to appear. Where the naphthalene had been buried and also where it had been covered, the growth of the plants was somewhat retarded but the yield from these plats was not significantly lower than the yield from the check plats and those where the naphthalene was uncovered.

In conclusion it might be stated that poison bran bait, a Paris green–brown sugar bait, carbon disulfide emulsion, corrosive sublimate, derris, *Creolol*, *Cyanogas*, an ethylene dichloride–carbon tetrachloride mixture, 3 per cent nicotine dust, and fish scrap gave unsatisfactory results in these tests for the control of the pavement ant. *Halowax*, *Loro* and naphthalene flakes gave promising results. Naphthalene flakes gave the most lasting protection but appeared to have a retarding effect upon the growth of the plants where it was applied in close contact with the roots. —2-17-37.

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Experiments with Calcium Arsenate to Control Codling Moth[1]

Byrley F. Driggers, *New Jersey Agricultural Experiment Station, New Brunswick*

Establishment by the Pure Food and Drug Administration of the United States Department of Agriculture of a lead tolerance on fruit and vegetables in 1933 led to a rather extensive substitution of calcium arsenate for lead arsenate for apple spraying during that season. In general, the results proved unsatisfactory in that, pound for pound, calcium arsenate was not as effective as lead arsenate in stopping the larvae.

[1] Paper of the Journal series, New Jersey Agricultural Experiment Station, Department of Entomology.

Also more burning of fruit and foliage resulted from the use of calcium arsenate. The writer's results that season with two brands of calcium arsenate, one of which was supposed to be an "improved" type, were in line with the above findings. The results in 1933 with calcium arsenate used as a substitute for lead arsenate in codling moth control were so unpromising that no work was done with this material in New Jersey in 1934 and 1935.

Results recently published by Marshall & Groves (1936) working in the state of Washington, and Pearce, Norton & Chapman (1935) working in New York, revived interest in the calcium arsenate as a spray for codling moth control. Marshall & Groves showed that under their conditions where equal or greater deposits of calcium arsenate were maintained, the degree of codling moth control compared favorably with that obtained from the use of lead arsenate alone or with lead arsenate and oil. The work of Pearce, Norton & Chapman showed that different brands of calcium arsenate differed in the degree of burning of apple foliage and that the difference was due to the amount of water-soluble arsenic present after the free lime normally occurring in calcium arsenates was removed. They tested a number of brands of calcium arsenate, both in the laboratory and field, and found that all brands which were relatively safe in the field analyzed less than .75 per cent water soluble As_2O_5 whereas those that were found to be unsafe analyzed between 4 and 12 per cent water-soluble As_2O_5.

On the strength of the work referred to it was decided to select a brand of calcium arsenate from among the group found relatively safe on foliage by the New York investigators and test it in comparison with lead arsenate in two of the spray schedules recommended for codling moth control in New Jersey. In the first or state-wide schedule lead arsenate–lime–milk is recommended at approximately 10-day intervals. In the second schedule recommendations are made for those orchards where codling moth has not been satisfactorily controlled by the first schedule and calls for the use of summer oil emulsions with lead arsenate at the peak of first and second-brood egg deposition. It was decided to compare the calcium arsenate with the lead arsenate on a pound for pound basis. The calcium arsenate in the oil schedule was tested in a heavily infested orchard at Glassboro on the Winesap and Stayman varieties. It was tested in the lime–milk schedule at Moorestown in a moderately infested orchard on the Rome, Wealthy and Stayman varieties.

Experiments at Glassboro.—At Glassboro, plot 1, consisting of four Winesap and 10 Stayman trees, was sprayed with calcium arsenate 4 pounds, *Coposil* 2 pounds, lime 2 pounds and *Ortho* dry spreader one-fourth pound to 100 gallons at the 7-day-after-petal-fall spray. At the 17-day and the 27-day, or second and third cover sprays, this plot was sprayed with calcium arsenate 2 pounds, *Coposil* 2 pounds, lime 2 pounds, *Ortho* dry spreader one-fourth pound and *Orthol-K* oil 3 quarts to 100 gallons. The 37-day cover spray consisted of calcium arsenate 2 pounds, *Ortho* dry spreader one-fourth pound and *Orthol-K* 3 quarts to 100 gallons. The 47-day and 57-day cover sprays consisted of calcium arsenate 4 pounds, lime 8 pounds, *Ortho* dry spreader one-half pound to

100 gallons. The 67-day cover spray consisted of calcium arsenate 2 pounds, *Ortho* dry spreader one-half pound and *Orthol-K* 3 quarts to 100 gallons. The 77-day cover spray consisted of calcium arsenate 3 pounds, lime 6 pounds, *Ortho* dry spreader one-half pound to 100 gallons. The first four sprays listed above covered first-brood larval activity and the last four covered second-brood activity.

Plot 2, consisting of 10 Winesap and 16 Staymen trees, was sprayed with lead arsenate 4 pounds, *Coposil* 2 pounds, lime 2 pounds and *Ortho* dry spreader one-fourth pound to 100 gallons at the 7-day-after-petal-fall spray. At the 17-day and 27-day cover sprays this plot was sprayed with lead arsenate 2 pounds, *Coposil* 2 pounds, lime 2 pounds, *Ortho* dry spreader one-fourth pound *Orthol-K* oil 3 quarts to 100 gallons. The

Table 1.—Codling moth control on Winesap apples and arsenic deposit on Stayman apples sprayed with calcium arsenate–oil and lead arsenate–oil.

Plot No.	Treatment	Per Cent Apples Clean	Per Cent Apples Stung	Per Cent Apples Wormy	Deposit* Top	Deposit* Bottom
1	Calcium arsenate–oil both broods	11.6	30	58.4	44.3	77.2
2	Lead arsenate–oil first brood only	14.8	25.7	59.5		
3	Lead arsenate–oil both broods	20.9	44.2	34.9	44.9	72.1

* Deposit in micrograms As_2O_3 per square inch of leaves top and bottom of tree. Averages of six samples taken at the end of 10 days of weathering following first to sixth cover sprays.

37-day cover spray consisted of lead arsenate 2 pounds, *Ortho* dry spreader one-fourth pound and *Orthol-K* oil 3 quarts to 100 gallons. These four sprays covered the period of first-brood larval entry. No additional sprays were applied on this plot for second brood.

Plot 3, consisting of 10 Winesap and 16 Stayman trees, was sprayed the same as plot 2 on the four first-brood cover sprays. In addition this plot was sprayed three times for second brood as follows: the 47-day cover spray consisted of lead arsenate 4 pounds, lime 8 pounds, *Ortho* dry spreader one-half pound to 100 gallons; the 57-day and 67-day cover sprays consisted of lead arsenate 2 pounds, *Ortho* dry spreader one-half pound, *Orthol-K* oil 3 quarts to 100 gallons.

Data on codling moth control were taken by examining all the apples, including drops collected once a week from September 1 to harvest the first week in October, on four Winesap trees in each of the three plots. In addition the relative sticking quality of the calcium arsenate–oil on plot 1 and the lead arsenate–oil on plot 3 was determined by analyzing the foliage for As_2O_3 at the end of the 10-day periods of weathering following the first to the sixth cover sprays inclusive. Table 1 sets forth for the three plots the percentages of clean, stung and wormy apples and also the As_2O_3 deposit on foliage taken from the tops and bottoms of the Stayman trees in plots 1 and 3. The deposit figures represent the average of six samples taken at the end of 10 days weathering following the first to sixth cover sprays.

The data in table 1 show that the arsenical residue at the end of 10 days of weathering was about the same on the calcium arsenate–oil-sprayed plot as on the lead arsenate–oil-sprayed plot. This would indicate greater loss due to weathering in the case of the calcium arsenate–oil because of the higher arsenic content of the calcium arsenate. Turning to the control figures we find 58.4 per cent of the fruit wormy on plot 1 sprayed four times for first brood, three of which were calcium arsenate–oil; and four times for second brood, one of which was calcium arsenate–oil. Plot 2, sprayed four times for first brood, three of which were lead arsenate–oil, and no sprays for second brood was only slightly higher in wormy fruit with 59.5 per cent than plot 1. Plot 3, sprayed

Table 2.—Codling moth control on Rome apples and arsenic deposit on Stayman apples sprayed with calcium arsenate, lead arsenate and lead arsenate-oil.

Plot No.	Treatment	Per Cent Apples Clean	Per Cent Apples Stung	Per Cent Apples Wormy	Deposit* Top	Deposit* Bottom
1	Lead arsenate–lime both broods	80.2	16.8	3	35	50
2	Calcium arsenate–lime both broods	60.5	15	24.5	31	51
3	Lead arsenate–lime both broods	81	15	4		
4	Lead arsenate–lime first brood only	59.6	18.8	21.6		
5	Lead arsenate–oil both broods	83.4	14.5	2.1		
6	Lead arsenate–oil first brood only	72.8	16.1	11.1		

* Deposit in micrograms As_2O_3 per square inch of leaves top and bottom of tree. Averages of six samples at end of 10 days weathering.

four times for first brood, three of which were lead arsenate–oil, and three times for second brood, two of which were lead arsenate–oil, produced only 34.9 per cent of the fruit wormy. These figures show that calcium arsenate–oil was inferior to lead arsenate–oil in preventing worm entry.

Experiments at Moorestown.—At Moorestown, calcium arsenate–lime–milk was compared to lead arsenate–lime–milk and also to lead arsenate–oil. To bring out more clearly the differences between treatments, half of the lead arsenate–lime–milk plots and half of the lead arsenate–oil plot received no sprays for second brood.

The plots at Moorestown consisted of 48 trees about equally divided among the varieties Rome Beauty, Wealthy and Stayman. Data on worm control were taken by examining all the fruit on three of the Rome trees in each plot including the drops picked up once a week beginning September 1. The figures on arsenic deposit were taken from Stayman plots at Glassboro sprayed the same as the plots at Moorestown.

Plot 1 at Moorestown was sprayed five times for first brood at 10-day intervals using led arsenate 3 pounds, lime 6 pounds, milk one-fourth pound to 100 gallons. For second brood control this plot received three sprays at 10-day intervals using the same materials at the same rate.

Plot 2 was sprayed five times for first brood and three times for second brood at 10-day intervals using calcium arsenate 3 pounds, lime 6 pounds, milk one-fourth pound. Plot 3 was sprayed the same as plot 1. Plot 4 was sprayed the same as plots 1 and 3 for first brood but received no second-brood sprays. Plot 5 received lead arsenate 3 pounds, lime 6 pounds and *Ortho* dry spreader one-half pound in the first, second and fifth cover sprays and lead arsenate 2 pounds, *Ortho* dry spreader-one-half pound and *Orthol-K* oil 3 quarts in the third and fourth cover sprays for first brood. For second brood the sixth cover spray was lead arsenate 3 pounds, lime 6 pounds, *Ortho* dry spreader one-half pound; and the seventh and eighth cover sprays were lead arsenate 2 pounds, *Ortho* dry spreader one-half pound, *Orthol-K* oil 3 quarts. Plot 6 was sprayed the same as plot 5 for first brood but received no second-brood sprays. Amounts of materials are on the basis of 100 gallons.

Table 2 sets forth the percentages of clean, stung and wormy fruit and also the arsenic deposit on the Stayman foliage at the end of 10 days of weathering. The deposit figures represent the average of six samples taken at the end of 10 days following the first to sixth cover sprays.

The data in table 2 show that there was little difference in deposit of As_2O_3 at the end of 10 days of weathering between the calcium arsenate–lime and the lead arsenate–lime. In regard to worm control, plots 1 and 3, sprayed with lead arsenate–lime–milk for both broods, showed 3 and 4 per cent wormy fruit respectively, whereas plot 2 sprayed with calcium arsenate–lime–milk, showed 24.5 per cent wormy fruit. The inferiority of the calcium arsenate in preventing larval entry is demonstrated further by the fact that plots 4 and 6, which received for first-brood control lead arsenate–lime and lead arsenate–oil respectively but no second-brood sprays, came through with less wormy fruit than did the plots sprayed with calcium arsenate alone.

Discussion.—Results on worm control with calcium arsenate, in both the oil schedule at Glass boro and the lime–milk schedule at Moorestown, show this material inferior to lead arsenate. Examination of the literature dealing with the use of calcium arsenate in comparison with lead arsenate for the control of codling moth will show that most investigators have found calcium arsenate inferior to lead arsenate. The reason generally ascribed for the failure of calcium arsenate to measure up to lead arsenate is the inferior sticking quality of the former. Another reason suggested is that the lead of the lead arsenate produced an additional kill, which is not true of the calcium in the calcium arsenate.

The fact that the arsenical deposit figures for calcium arsenate were about the same as those for the lead arsenate would seem to rule out the supposedly better sticking properties of the lead arsenate as being responsible for the difference. It seems unlikely also that the marked difference in efficiency can be ascribed to the additional toxicity of the lead in the lead arsenate. A third factor not heretofore given much consideration might be advanced to account for the superiority of a lead arsenate coating over a calcium arsenate coating in preventing codling moth entry. This factor is the physical nature of the deposit produced on fruit and foliage by the two arsenicals. In the case of lead

arsenate an oily, dusty deposit is obtained which resists washing by rains yet is readily disturbed or brushed off by hand or otherwise. On the other hand, a calcium arsenate, or calcium arsenate–lime coating has an appearance of "whitewash" and has less of the oily, dusty characteristic noted in the case of lead arsenate. It is suggested that a recently hatched codling moth larva crawling over fruit and foliage coated with lead arsenate picks up a lethal dose of arsenic more readily than a larva crawling over calcium arsenate-coated fruit and foliage even though the arsenic deposit per unit area of fruit and foliage is the same with both materials. That the physical nature of an insecticide coating might influence the control of an insect is shown in the case of fixed nicotine in some data published recently by the writer (1936).

No difference in foliage burn was observed between the calcium arsenate and lead arsenate-sprayed plots. However, a corrective in the form of hydrated lime or Bordeaux mixture was used with each of the arsenicals.

Summary.—Calcium arsenate was compared pound for pound with lead arsenate in a schedule with summer oil used three times on first brood and once on second brood in a Glassboro orchard heavily infested with codling moth. Approximately twice as many larvae succeeded in entering the apples on the plot sprayed with calcium arsenate as on the plot sprayed with lead arsenate even though the arsenic deposit on the two plots was approximately equal. The inferiority of the calcium arsenate was further brought out by the fact that a plot sprayed with lead arsenate–oil for first brood, but which received no second-brood sprays, had no more worm entries than the calcium arsenate plot which received the same number of first-brood sprays plus second-brood sprays.

At Moorestown calcium arsenate was compared to lead arsenate in the lime–milk schedule. Approximately eight times as many larvae gained entrance to the fruit sprayed with calcium arsenate–lime–milk as gained entrance to the fruit sprayed with lead arsenate–lime–milk. A plot sprayed with lead arsenate–lime–milk first brood only and a plot sprayed with lead arsenate–oil first brood only, had fewer worm entries than the calcium arsenate–lime–milk plot sprayed for both the first and second broods.

It is suggested that the superiority of lead arsenate over calcium arsenate as a spray for codling moth may be due to the superior physical properties of the lead arsenate over the calcium arsenate.—3-19-37.

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The California Department of Agriculture on February 10, 1937, issued a quarantine proclamation relating to the satin moth in New England and parts of Washington and Oregon, prohibiting the entry of the host plants originating in the infested areas.

Biology and Control of the Juniper Webworm in Maryland

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Twenty-six years ago Felt (1911) definitely recorded the juniper webworm, *Dichomeris marginellus* Fabr., a European species, as occurring in this country. There is evidence (Britton, 1915) that it was present and causing injury prior to this. Several writers, notably Felt (Felt & Rankin, 1932) and Britton (Britton & Zappe, 1927), have on occasions discussed its depredations and given valuable notes on its habits and control. In 1922, Weiss & Lott published an excellent paper describing the several stages and giving an account of the life habits.

The juniper webworm made its appearance as an injurious insect in Maryland in 1931. Since that time it has spread quite generally over the state, and is without doubt the most injurious insect in the state attacking *Juniperus communis*. Damage to the following varieties has been observed: *depressa*, *depressa aurea*, *hibernica* and *suecica*. Other species of junipers, even when adjacent to *communis*, have not been observed to be attacked.

Damage, as the name webworm denotes, is usually first observed as webbed and brown foliage. The newly hatched larvae begin feeding upon the upper surface of the needles, causing them to turn brown and die. Webbing starts soon after the larvae begin to feed. The terminal shoots are usually the first part of the plant to be webbed. Later the webbing encloses more and more of the plant. If the infestation is heavy enough the entire plant may be involved. The writer has seen large plants, 6 and 8 feet high, completely brown, without green foliage, and webbed from top to bottom.

Biology and seasonal history.—The juniper webworm has but one brood a year. The winter is passed as partly grown larvae in silken cases within the webbed foliage. The full-grown larvae are 12 to 15 mm. long and characterized by a light brown body bearing a narrow reddish brown median line paralled by two wider dark-brown lateral stripes. The head and body segments bear short white hairs, most of which arise from tubercles. The head, thoracic shield and legs are dark brown to black. In early spring the larvae resume feeding and complete their growth. The overwintering larvae vary considerably in size and consequently mature over a period of six to eight weeks in the spring. The apparent cause for this is an age difference of at least that much between individual larvae, and also a difference in temperature to which larvae in different parts of the tree are exposed. The latter has been indicated by many field observations, as is evidenced by the following typical cases. On May 8, 1935, a tree divided into two equal exposures showed 0 per cent pupae on the north side and 21 per cent on the south side. In the same locality and on the same date, in 1936, 6.4 per cent of the larvae had pupated on the north side and 29.4 per cent on the south side. The temperature difference may be further analyzed by dividing the tree into four equal exposures. At Rockville, on May 15, 1935, the following condition prevailed with regard to the percentage of larvae which had

pupated: northwest side, 0 per cent; northeast side, 3.4 per cent; southeast side, 24.1 per cent; southwest side, 41.3 per cent.

The slender reddish brown pupae are 5 to 7 mm. long. Pupation takes place in whitish silken cases among the webbed foliage and may occur over a period of two months. Some larvae, depending on the season, may pupate as early as April 25, others as late as June 27. The greatest number of pupae are usually found in the field between May 22 and June 1. The pupal period varied from 10 to 20 days with an average of about 16 days. Adults have been observed to emerge as early as May 19, and as late as July 7. The peak of emergence normally takes place between June 1 and June 10. The general prevalence of the several stages under field conditions for different years is given in table 1.

Table 1.—Relative abundance of several stages of the juniper webworm under field conditions.

Date	Locality	Percentage Larvae	Percentage Pupae	Percentage Adults Emerged
April 30, 1931	Cottage City	89.3	10.7	.0
May 3, 1935	Rockville	95.6	4.4	.0
May 8, 1935	Towson	84.7	15.3	.0
May 8, 1936	Rockville	81.5	18.4	.0
May 15, 1935	Rockville	82.8	17.2	.0
May 19, 1931	College Park			1.2
May 23, 1935	Rockville	70.4	29.6	.0
May 24, 1936	Rockville	12.5	75	12.5
May 27, 1931	College Park			7.1
June 1, 1931	Cottage City	9.5	32.1	58.4
June 10, 1936	Rockville	3.7	24.5	71.7
June 18, 1936	Rockville	1.5	11.8	86.7
June 25, 1935	Towson	7.6	18.4	74
June 27, 1936	Rockville	.0	.0	100
July 3, 1935	Rockville	.0	15.9	84.1

Weiss & Lott (1922) described the adult as follows: "The adult is rather attractive. The fore wings are brown with white front and rear margins, the white disappearing before reaching the apex of the wing. The hind wings are uniformly pearl gray above and below, shining and heavily fringed. The thorax and abdomen above and below are light brown and a tuft of creamy white hairs on the head and prothorax. The wing spread is about 15 mm., and length about 7 mm."

The longevity of the adult has not been determined for normal conditions. In the laboratory adults have been kept living on water for 20 days. Comprehensive data on the number of eggs a female may lay were not obtained. Ten fertile females were confined for records. The minimum number of eggs laid was six, the maximum 147 and the average 48.

When laid, the eggs are whitish, .5 to .6 mm. long and .25 to .3 mm. in width. They are somewhat cylindrical with broadly rounded ends and are sculptured with irregularly parallel wavy ridges. They may be found deposited, usually singly, in the axils of the leaves surrounding the terminal shoots of the host. After three to four days the eggs become pinkish. The black spot appears about one day before hatching. The incubation period is 10 to 14 days.

Larvae have been found hatching in the insectary as early as May 27.

In the field the earliest they have been observed was on June 22, 1931. However, it would seem from available life history data that a few may hatch in the field earlier, although new larvae are not easily found prior to July 1. Soon after hatching, the young larvae begin to feed and construct their webs. Characteristic webbing is usually in evidence by July 15. Heavily infested trees may show brown foliage by August 1. Apparently the larvae are active until the advent of cold weather. At least 10 months of each year are spent in the larval stage.

Natural enemies.—During these observations, several parasites were encountered attacking larvae and pupae.

It was not uncommon to find larvae being attacked, during both fall and spring, by the mite *Pediculoides ventricosus* (Newport). In late spring the hymenopterous parasite *Horismenus microgaster* Ashm. was frequently found emerging from larvae. The parasites *Dibrachys cavus* Walk., *Ephialtes aequalis* (Prov.), *Itoplectis conquisitor* (Say) and *Habrocytus* sp. were bred from pupae. It was not determined whether the parasites *Horismenus microgaster* Ashm., *Dibrachys cavus* Walk. and *Habrocytus* sp. were primary on secondary.

No detailed observations were made on the effectiveness of any of the above parasites. However, in 1935, 18 per cent of the pupae, in an infestation near Rockville, were killed by the combined action of the above pupal parasites.

Control.—Control tests[1] indicate that arsenate of lead as a spray is an efficient remedy. A spreader is not necessary. In a series of tests spraying with arsenate of lead, 2 pounds in 50 gallons of water, at approximately monthly intervals from July 1 to October 1 and from March 1 to May 1 gave an average kill of 97.2 per cent. Sprays applied between May 1 and May 20 were not as effective because too many larvae had finished feeding and were in the process of transformation. However, arsenate of lead applied during that period, or even much earlier in the spring, is quite effective in preventing injury by the new generation. Because of its residue, arsenate of lead proved to be superior to pyrethrum and rotenone sprays.

To test this point, which was apparent from general observations, a series of sprays and dusts was applied on May 8, 1936. The trees treated were in a heavily infested nursery block and were therefore adjacent to infested trees not sprayed. On October 14 results were as follows:

Arsenate of lead (2 pounds to 50 gallons of water)—*no infestation.*
Arsenate of lead dusts (1:6 parts of sulfur)—*medium to heavy infestation.*
Arsenate of lead dust (undiluted)—*very lightly infested.*
Calcium arsenate dust (undiluted)—*very lightly infested.*
Pyrethrum soap sprays (dilutions ranging from 1:200 to 1:600)—*heavily infested.*
Rotenone sprays (several dilutions of rotenone-bearing proprietary sprays and 2 pounds of 3 per cent retenone dust in 50 gallons of water with and without spreader)—*heavily infested.*
Pyrethrum dust (60 per cent pyrethrum)—*heavily infested.*
Rotenone dust (3 per cent rotenone)—*heavily infested.*
Ground Quassia—*heavily infested.*

When used at dilutions sufficiently strong and care was taken to wet

[1] Test materials furnished by McCormick Sales Company and The Davison Chemical Corporation, Baltimore.

all larvae with the solution, pyrethrum soap sprays applied between July 1 and October 1 and between March 1 and May 1 appeared to give as good a kill as arsenate of lead. The material used contained about 2 per cent pyrethrins and gave an average kill of 97.3 per cent at a dilution of 1:200, and 96.4 per cent at a dilution of 1:400.

A dust of either undiluted arsenate of lead or calcium arsenate is effective if applied during summer or early fall. Diluted arsenate of lead was not promising. One test made early in April, using arsenate of lead, diluted 1 part in 6 parts of 300-mesh sulfur, was not effective. After 21 days only 68.4 per cent of the larvae were dead.

Two tests, one in the spring and another during late summer, made with a 60 per cent pyrethrum dust, gave 79.6 per cent kill for the spring application and 94.4 per cent for the summer application.

Results obtained with rotenone dusts have been variable. The best kill, 73.3 per cent was obtained with a .75 per cent rotenone dust applied during late summer.—12-30-36.

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Further Tests with Pyrethrum as an Insecticide for Cabbage Worms

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As a result of preliminary tests on Long Island in 1935 (Huckett, 1936) it became evident that pyrethrum might be a more effective insecticide than rotenone-containing powders for control of the cabbage looper, locally a serious pest of cauliflower. Additional experiments were initiated in 1936 for the purpose of obtaining further information as to the value of various pyrethrum products in cabbage worm control. Tests were carried out under insectary conditions on the early instars of the zebra caterpillar, *Mamestra picta* Harr., and under field conditions for control of the cabbage looper, *Autographa brassicae* Riley, with a view to determining what strength of pyrethrum dust mixture might be most effective for commercial purposes and what diluent, if any, might prove to be more satisfactory than others when mixed with the more heavily impregnated pyrethrin powders. Identical mixtures were used in the insectary and field tests, the formulae for which are given in the accompanying tables.

Three types of pyrethrum products were tried in the experiments, namely, (1) ground pyrethrum flowers of 120-mesh fineness and of .9

and .6 per cent pyrethrin strength, (2) an inert material impregnated with the extractives of pyrethrum flowers to carry 2 per cent pyrethrin content,[1] (3) pyrethrum power of 100-mesh fineness, impregnated with the extractives of pyrethrum flowers to a pyrethrin strength of .5 per cent.[2] Four inert materials were tested for purposes of dilution and efficiency, namely clay, talc, gypsum and infusorial earth.[3] In all mixtures of ground pyrethrum flowers with clay, talc or gypsum, infusorial earth was included as a fluffing agent at the rate of 2 pounds per 100 pounds of finished dust; and in the case of similar mixtures with impregnated powders at the rate of 5 pounds. Where infusorial earth was used

Table 1.—Effectiveness of pyrethrum dust mixtures of different strengths against early instars of the zebra caterpillar.

Parts by Weight	Approx. Pyrethrin Strength	No. Tests	No. Worms	Average Dosage per Test	Percentage Mortality
	Per Cent			Grams	
Pyrethrum powder, .9% PC,* 65, *Celite* 2, clay 33.	.6	6	134	.56	92.4±1.12†
Pyrethrum powder, .9% PC, 55, *Celite* 2, clay 43.	.5	6	138	.55	69.0±2.54
Pyrethrum powder, .9% PC, 45, *Celite* 2, clay 53.	.4	6	169	.55	32.9±1.06
Check		*6*	*145*		4.9
Pyrethrum powder, .6% PC.	.6	18	420	.47	98.0±0.77
Pyrethrum powder, .6% PC, 80, *Celite* 2, clay 18.	.5	12	300	.55	96.9±2.57
Pyrethrum powder, .6% PC, 65, *Celite* 2, clay 33.	.4	12	297	.55	71.6±1.97
Check		*12*	*272*		*3.6*

* PC = pyrethrin content. † Probable error.

alone as a diluent it was included in the formula on a volume basis, replacing the heavier inert material at the arbitrary ratio of 1 to 4 pounds respectively. The relative densities[4] for these diluents, or vibrated weight in pounds per cubic foot, were as follows: gypsum–*Terra Alba* 59.28, talc 43.624, *Brancroft Clay* 39.064, and *Celite* 12.5.

Insectary tests.—The procedure followed was in general similar to that described for previous tests in 1935, to which reference has been made. Colonies of *Mamestra picta* were gathered in the field as opportunity offered during September. Larvae were divided into about equal quotas of 24 worms each, and placed in paper cups for treatment. Immediately after being dusted each quota was removed to a shallow aluminum dish lined with absorbent paper and containing food, over which was fitted a dome-shaped gauze covering. Mortality counts were made 48 hours after treatment. The data for these series of tests are summarized in tables 1 and 2.

In table 1 dust mixtures of .6, .5 and .4 per cent pyrethrin strength are compared, when formulated from stock pyrethrum powders of different pyrethrin content. The mortality obtained with mixtures having a stock powder of .6 per cent pyrethrin content was generally more satisfactory than that obtained with dusts having a stock powder of .9 per

[1] *Pyrocide.*
[2] *Powco Activated "A" Dust.*
[3] *Bancroft Clay, Loomkill, Terra Alba* and *Celite*, respectively.
[4] Supplied by Johns-Manville through the courtesy of J. V. Miller of McLaughlin Gormley King Company.

cent pyrethrin content. This was especially marked at the lower finished strengths of .5 and .4 per cent pyrethrin, a result which seems to be in some measure correlated with the increasing extent of particle dilution in mixtures containing the stock powder of higher pyrethrin content.

In table 2, dust mixtures are compared containing clay, talc, gypsum or infusorial earth as a diluent, and when formulated with three types of pyrethrum products as active ingredients. The pyrethrin strength of the dust mixtures was arbitrarily fixed at .5 per cent where ground flowers

Table 2.—Effectiveness of dust mixtures containing powdered pyrethrum flowers and impregnated pyrethrin powders with various diluents against early instars of the zebra caterpillar.

Parts by Weight	Approx. Pyrethrin Strength	No. Tests	No. Worms	Average Dosage per Test	Percentage Mortality
	Per Cent			Grams	
Pyrethrum powder, .9% PC,* 55, *Celite* 2, clay 43.	.5	6	126	.6	66.7±1.98†
Pyrethrum powder, .9% PC, 55, *Celite* 13.	.5	6	137	.2	82.5±2.38
Pyrethrum powder, .6% PC, 80, *Celite* 2, clay 18.	.5	6	146	.65	90.3±1.44
Pyrethrum powder, .6% PC, 80, *Celite* 6.	.5	6	142	.3	93.8±1.68
Check		*6*	*128*		*.83*
Impregnated inert, 2% PC, 10, *Celite* 5, clay 85.	.2	18	432	.52	67.8±2.15
Impregnated inert, 2% PC, 10, *Celite* 5, talc 85.	.2	12	305	.53	89.0±1.03
Impregnated inert, 2% PC, 10, *Celite* 5, gypsum 85.	.2	12	300	.6	95.6±1.3
Impregnated inert, 2% PC, 10, *Celite* 26.	.2	12	270	.24	98.9±1.96
Impregnated powder, .5% PC, 40, *Celite* 5, clay 55.	.2	18	412	.54	73.3±2.10
Impregnated powder, .5% PC, 40, *Celite* 5, talc 55.	.2	12	309	.55	90.3±1.14
Impregnated powder, .5% PC, 40, *Celite* 5, gypsum 55.	.2	12	288	.65	96.6±1.28
Impregnated powder, .5% PC, 40, *Celite* 19.	.2	12	277	.32	96.8±1.3
Check		*18*	*409*		*1.68*

* PC = pyrethrin content. † Probable error.

were employed and .2 per cent where impregnated powders were used. The two most notable features brought out by the comparisons were the invariably diminished effectiveness of dusts where clay formed the diluent, and the high mortality obtained by light-weight dosages of dusts where infusorial earth alone formed the diluent. As in table 1, there was a tendency to a lower level of achievement in the case of pyrethrum powders where dilutions became greater by virtue of the use of a stock powder of higher pyrethrin strength. The diminished effectiveness of impregnated dusts when diluted with clay was thought to be partly due to the greater absorptive properties of clay, which thus interfered with the potency of the active elements. The marked effectiveness of dust mixtures with *Celite* alone as the diluent, the formulation of which was placed on a volume basis on account of the lower density of the diluent, was evidently due to the greater concentration of active ingredients comprising these dusts.

Field tests.—The experiment was carried out in duplicate on two adjoining fields of cauliflower during August and September, the final

data being taken during the first week of October just prior to the tying of the leaves. During this period worm injury, as shown by the check plants, was considered light and of little commercial importance in one field and of more disquieting proportions in the other. Population counts on 20 check plants in October averaged .7 individuals of *Pieris rapae* L., 8.8 of *A. brassicae*, and 3.3 of *Plutella maculipennis* Curt. per plant in the field considered lightly injured (series 1), and .5 of *P. rapae*, 8.8 of *A. brassicae*, and 15.6 of *P. maculipennis* in the field that had showed more serious feeding injury during the experimental period (series 2). Plots were arranged according to the Latin square system, each treatment being replicated four or five times in row-units of about 35 to 40 plants each. Applications of dust invariably were made under favorable

Table 3.—Effectiveness of pyrethrum dust mixtures of different strengths for control of cabbage worms on cauliflower as denoted by foliage and frass injury.

Parts by Weight	Approx. Pyrethrin Strength	Series 1 Per Cent of Plant Injury			Series 2 Per Cent of Plant Injury			Average Increase over Checks in Plants with Trace of Injury
	Per Cent	Trace	Slight	Moderate to Severe	Trace	Slight	Moderate to Severe	Per Cent
Pyrethrum powder, .9% PC,* 65, *Celite* 2, clay 33.	.6	74	22	4	70	24	6	36
Pyrethrum powder, .9% PC, 55, *Celite* 2, clay 43.	.5	73	25	2	62	29	9	31.5
Pyrethrum powder, .9% PC, 45, *Celite* 2, clay 53.	.4	58	29	13	54	31	15	20
Check		*49*	*34*	*17*	*23*	*32*	*45*	
Pyrethrum powder, .6% PC.	.6	84	14	2	84	14	2	52.5
Pyrethrum powder, .6% PC, 80, *Celite* 2, clay 18.	.5	82	18	0	77	20	3	48
Pyrethrum powder, .6% PC, 65, *Celite* 2, clay 33.	.4	80	19	1	68	22	10	42.5
Check		*40*	*39*	*21*	*23*	*35*	*42*	

* PC = pyrethrin content.

weather conditions in the early morning, treatments being made on August 25, September 9 and 23 in series 1, and on August 28, September 11 and 26 in series 2. All mixtures except those containing infusorial earth alone as diluent were applied by means of a fan type of hand duster, going once over the plants: the average estimated rate of application in series 1 increased from 16½ to 25 pounds per acre per treatment as the season progressed, and in series 2 from 20 to 32 pounds per acre per treatment. The mixtures diluted with infusorial earth only were applied by means of a puff type of hand duster, the average estimated rate of application in series 1 being 4½ to 6 pounds per acre per treatment, and in series 2 from 4½ to 8 pounds per acre per treatment during successive applications. The effectiveness of the various mixtures in controlling cabbage worms was estimated according to the relative amount of feeding injury showing on the inner foliage and by the extent of frass accumulation at the bases of the inner leaves. Plant injuries were classified under four arbitrary headings, namely none or trace, slight, moderate and severe. Control was considered satisfactory for commercial purposes where slight or no injury was present.

The data from these series of tests are summarized in tables 3 and 4. In table 3 the comparisons presented are from field treatments made with dust mixtures identical with those discussed in reference to table 1. In general these data tend to corroborate the evidence presented by table 1. The degree of control obtained as denoted by feeding injuries seemed in part to bear some relation to the extent of dilution in the finished dust mixture. Thus, mixtures containing a stock pyrethrum

Table 4.—Effectiveness of dust mixtures containing powdered pyrethrum flowers and impregnated pyrethrin powders with various diluents for control of cabbage worms on cauliflower as denoted by extent of foliage and frass injury.

Parts by Weight	Approx. Pyrethrin Strength	Series 1 Per Cent of Plant Injury			Series 2 Per Cent of Plant Injury			Average Increase over Checks in Plants with Trace of Injury
	Per Cent	Trace	Slight	Moderate to Severe	Trace	Slight	Moderate to Severe	Per Cent
Pyrethrum powder, .9% PC,* 55, *Celite* 2, clay 43.	.5	68	29	3				
Pyrethrum powder, .9% PC, 55, *Celite* 2, talc 43.	.5	80	20	0				
Pyrethrum powder, .9% PC, 55, *Celite* 2, gypsum 43.	.5	87	13	0				
Pyrethrum powder, .9% PC, 55, *Celite* 13.	.5	86	14	0				
Check		*43*	*39*	*18*				
Impregnated inert, 2% PC, 10, *Celite* 5, clay 83.	.2	68	28	4	37	38	25	13.5
Impregnated inert, 2% PC, 10, *Celite* 5, talc 85.	.2	73	23	4	63	25	12	29
Impregnated inert, 2% PC, 10, *Celite* 5, gypsum 85.	.2	81	18	1	63	31	6	33
Impregnated inert, 2% PC, 10, *Celite* 26.	.2	76	21	3	53	31	16	25.5
Check		*53*	*34*	*13*	*25*	*34*	*41*	
Impregnated powder, .5% PC, 40, *Celite* 5, clay 55.	.2	64	31	5	29	45	26	19.5
Impregnated powder, .5% PC, 40, *Celite* 5, talc 55.	.2	77	21	2	43	42	15	33
Impregnated powder, .5% PC, 40, *Celite* 5, gypsum 55.	.2	88	12	0	44	40	16	39
Impregnated powder, .5% PC, 40, *Celite* 19.	.2	83	17	0	47	39	14	38
Check		*42*	*37*	*21*	*12*	*30*	*58*	

* PC = pyrethrin content.

powder of .6 per cent pyrethrin content gave superior control to that obtained by mixtures having a powder of .9 per cent content, within a given range of strengths in the finished dusts. It is believed this is because of the greater concentration of active particles in the case of dusts made with the stock powder of lower pyrethrin analysis.

In table 4 data are presented relating to field treatments with dust mixtures identical with those compared and discussed in connection with table 2. For particulars of their use and formulation the reader is referred to previous statements regarding table 2 and to the description of field procedure at the commencement of this subheading. As in the case of insectary tests with *M. picta*, the two most notable features brought out by field tests for control of cabbage worms, as indicated in table 4, were the reduced effectiveness of dusts with clay as the diluent and the satisfactory control obtained with light-weight applications of mixtures

having infusorial earth alone as the diluent. The plants showing the least amount of injury invariably were found in plots dusted with gypsum mixtures. It should be mentioned that, as applied, not all dust mixtures were considered equivalent in value for dusting purposes, largely owing to differences in the densities of the diluents and in cost. With the *Niagara* hand duster, for example, clay–*Celite*–pyrethrum dusts were considered the cheapest, easiest and most pleasing to apply. In the case of gypsum dusts the flow was considered inferior but could be considerably improved for experimental purposes by tilting the hopper downwards in the direction of the feed. Mixtures with infusorial earth alone as the diluent could not be applied successfully with this type of duster as at present constructed, but could be effectively discharged by such mechanism as is provided in the *American Beauty* hand duster.

Summary.—Experiments are described concerning the effectiveness of pyrethrum dust mixtures when used in the insectary against the young larvae of *Mamestra picta* and for the control of cabbage worms under field conditions. Three types of pyrethrum products were tested, namely ground pyrethrum flowers of .9 and .6 per cent pyrethrin analysis, an inert material impregnated with the extractives of pyrethrum flowers to carry 2 per cent pyrethrin content, and pyrethrum powder impregnated to carry a pyrethrin strength of .5 per cent. Four inert materials were tried as diluents, namely clay, talc, gypsum and infusorial earth. The most notable features of the results in respect to the factors of pyrethrin strength in the finished dust and type of diluent were the greater effectiveness of dusts having a stock pyrethrum powder of lower pyrethrin analysis as compared with a higher analysis, and the diminished effectiveness of dusts having clay as the diluent in comparison with those containing talc, gypsum or infusorial earth.—2-3-37.

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Studies in Reducing Volume of Oil Necessary to Kill Mosquito Larvae

By Incorporating Pyrethrum[1]

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One phase of mosquito control work consists of periodically spraying mosquito-breeding waters with toxic fractions of petroleum oil (Ginsburg 1929, 1930, 1933) such as kerosene, light distillate fuel oils, or with suitable larvicides. In the field it usually requires 20 to 50 gallons of oil to cover an acre of water surface with a larvae-killing film. The quantity of oil required varies with the nature and location of the breeding

[1] Paper of the Journal series, New Jersey Agricultural Experiment Station, Department of Entomology.

place. The freer the water surface is from debris, vegetation, rubbish and other materials which tend to interfere with the spreading of the oil, the smaller is the amount of oil necessary to produce a killing film. The transportation of such large volumes of oil often presents a great handicap, especially on large areas of swamps and marshes where vehicular transportation of any kind is entirely impossible and human labor has to be resorted to. Furthermore, during recent years the airplane (Ginsburg, 1932) has been brought into use for distributing oil on large, otherwise inaccessible areas. Here again the necessity of reducing the load of oil per acre is keenly felt. Workers in mosquito extermination are therefore searching for some chemical, which when incorporated in kerosene or similar petroleum oil should increase its toxic power to such an extent that a much thinner film will be sufficient to produce 100 per cent kill of larvae. This would, of course, result in a reduction of the amount of oil required per acre spraying.

Pyrethrum is apparently the only material which has been up till now employed for this purpose. Pyrethrum extract incorporated in kerosene has been used by mosquito workers since 1929 in form of a dilute water in oil emulsion (Vannote & Ginsburg, 1931; Ginsburg, 1932, 1935; Smith, 1932) to control fresh and salt-water larvae. This emulsion, known as New Jersey Mosquito Larvicide, consists of about 66 per cent oil and 34 per cent water emulsified in such a way that it readily mixes with all kinds of water (Ginsburg, 1935) yet liberates the greater proportion of the oil and pyrethrins to the surface soon after spraying. It is generally applied at dilutions of 1:10 with water.

While this preparation made it possible to reduce the amount of actual oil to about 3 gallons per acre, thus eliminating injury (Ginsburg, 1930) to fish, waterfowl and vegetation, it did not in any way reduce the total volume of spray, since about 50 gallons of the dilute emulsion are usually required to liberate enough of the oil to form a toxic film.

Object.—The object of the experiments presented in this paper was to determine the smallest quantity of pyrethrum which will increase the toxicity of kerosene to such an extent that the minimum volume of oil by which it is physically possible uniformly to cover a given area of water should at the same time also produce a toxic film to mosquito larvae. It is the writer's opinion (based on laboratory and field observations) that this minimum for kerosene or similar light-petroleum distillates ranges from 3 to 6 gallons per acre, depending on temperatures, nature of the water and method of application.

Methods and results.—All the tests were conducted in the laboratory on larvae of the salt-marsh mosquito, *Aedes sollicitans* and of the fresh-water mosquito, *Culex pipiens*, using kerosene with different concentrations of pyrethrum extract, ranging from .01 to .1 per cent actual pyrethrins. The larvae, brought in daily from salt-water and fresh-water breeding places, were transferred to porcelain dishes of uniform size, containing 500 cc. of water. Fifty larvae selected from the third and fourth instars were used for each test and several tests were run with each dilution. The area of the water surface in the dish was carefully measured and found to be .27 square feet or approximately 1/161,370 of an acre. The amount of oil required to cover this surface, equivalent to one gallon

Table 1.—Toxicity of kerosene containing varying concentrations of pyrethrum to mosquito larvae, using 200 larvae per test.

Grams Pyrethrins Added to 1 Gallon Kerosene	Per Cent Concentration of Pyrethrins	Cc. Pyrethrum Extract No. 20 per Gallon Kerosene	Approximate No. Lbs. Pyrethrum Flowers in 1 Gallon Kerosene	Approximate No. Gallons Applied Per Acre	Average Per Cent Dead after							
					One-half Hr.	1 Hr.	2 Hrs.	24 Hrs.	One-half Hr.	1 Hr.	2 Hrs.	24 Hrs.
					Culex pipiens				*Aedes sollicitans*			
3.70	.10	190	1	6	100				96	98	100	
2.96	.08	152	.8	6	100				96	96	100	
2.22	.06	114	.6	6	90	98	100		90	90	96	100
1.48	.04	76	.4	6	90	96	100		82	92	96	100
.74	.02	38	.2	6	90	96	100		76	84	94	100
.37	.01	19	.1	6	82	86	94	100	60	78	88	100
3.70	.10	190	1	3	94	96	100		92	96	100	
2.96	.08	152	.8	3	90	94	100		94	94	100	
2.22	.06	114	.6	3	86	92	100		84	84	94	100
1.48	.04	76	.4	3	85	90	100		80	84	96	100
.74	.02	38	.2	3	78	94	98	100	64	76	88	100
.37	.01	19	.1	3	50	74	82	90	40	52	68	90
				Check Tests								
Kerosene only	0	0	0	3	24	50	55	70	10	16	20	50
Kerosene only	0	0	0	6	65	78	80	85	30	54	82	90
Kerosene only	0	0	0	12	76	84	98	98	23	58	92	99
Blank	0	0	0	0	0	0	0	0	0	0	0	2

per acre, was figured out to be .024 cc. Since the quantities of oil employed in these tests were 3, 6 and 12 gallons per acre, .07, .14 and .28 cc. respectively were required. Higher quantities of oil were not used because results from preliminary experiments have shown that under laboratory conditions kerosene by itself at the rate of 12 gallons per acre will kill 90 to 100 per cent of mosquito larvae. The oil was applied by pipette and the surface stirred with a glass rod in order to secure uniform distribution. Observations on the percentage kill were made at one-half hour; one, two and 24 hours after application. With each series of tests, kerosene alone was run as check. The kerosene employed for these tests was a standard grade, water white, of 45° Bé. The pyrethrum was used in a form of a concentrated kerosene extract of approximately 20 pounds of flowers to the gallon, and analyzed 1.96 per cent total pyrethrins of which 1.02 per cent was pyrethrin I and .94 per cent was pyrethrin II. The pyrethrins were analyzed by the Seil method (1933). The results are reported in table 1, where the actual concentrations of pyrethrins as well as their approximate equivalent in flowers is given.

Discussion.—Before interpreting the data in the table it should be noted that the salt-water species, *Aedes sollicitans*, proved somewhat more resistant to the oil–pyrethrum treatments than did the fresh-water species, *Culex pipiens*. The results should therefore be discussed separately for the two kinds of larvae. In each case the check of 12 gallons kerosene per acre without pyrethrum is taken as the minimum quantity of kerosene alone required to produce practically complete kill of mosquito larvae. The per cent dead larvae observed after two and 24 hours will be considered in comparing the results.

Culex pipiens.—The results on this species show that when 3 gallons per acre are applied it requires .02 per cent pyrethrins, or about .2 pounds of flowers to the gallon, to produce a kill equal to the check, namely, about 100 per cent within 24 hours, thus reducing the kerosene to exactly one-fourth the amount in the check. At the rate of 6 gallons per acre .01 per cent pyrethrins gave complete kill within 24 hours, but only 94 per cent kill within two hours as compared with 98 per cent for the check. The minimum in this case is apparently somewhere between .01 and .02 per cent pyrethrins.

Aedes sollicitans.—For the two-hour period it required .08 per cent pyrethrins to produce complete kill with either 3 or 6 gallons per acre. For the 24-hour period the minimum concentrations of pyrethrins which killed 100 per cent larvae were .02 and .01 per cent with 3 and 6 gallons per acre respectively. When compared, however, with the check, which gave only 92 per cent dead larvae after two hours, it required .04 and .02 per cent pyrethrins with 3 and 6 gallons respectively to produce a similar per cent kill.

Whether two or 24 hours should be used as the criterion for evaluating the rate of toxicity may be debatable. It seems to the writer, however, that the results from the two-hour period offer a safer index for determining the minimum concentration of pyrethrins to be incorporated in kerosene.

Summary.—Experiments were carried out in the laboratory with kerosene containing different percentages of pyrethrins on two species

of mosquito larvae with the purpose of ascertaining the smallest quantity of pyrethrins which will increase the toxicity of kerosene to the extent that the minimum volume of oil by which it is physically possible uniformly to cover a given area of water should at the same time also produce a toxic film to mosquito larvae. The results suggest that the toxicity of kerosene to mosquito larvae can be increased four times by incorporating .01 to .04 per cent actual pyrethrins, thereby reducing the volume of oil required to cover an acre of water surface under laboratory conditions from 12 to 3 gallons.—3-18-37.

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Control of Wireworms and Onion Thrips

By Carbon Bisulfide Carrying Naphthalene or PDB[1]

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Vegetable growers in the market garden area of the northern counties of New Jersey consider wireworms among the most important pests of cabbage, cauliflower, horseradish, beets and several other vegetable plants. In many cases wireworm attack is a limiting factor in the production of the early crop of these vegetables, which as a rule brings the highest net returns per acre.

Several species of wireworms, the larvae of the Elateridae, representing several different genera, are involved in damage to vegetable crops and for the sake of brevity these insects will be considered as a group.

History.—Much has been written in the past concerning the control of wireworms and Thomas (1930) has brought together all available information up to 1930 on this subject. Headlee (1926, 1927) showed

[1] Paper of the Journal series, New Jersey Agricultural Experiment Station, Department of Entomology.

that carbon bisulfide and carbon bisufide emulsion applied at the rate of 1 liquid ounce of actual CS_2 per square foot gave a kill of 80 per cent or higher. Calcium cyanide was also employed in the same experiments and satisfactory results were obtained, but the cost for both carbon bisulfide and calcium cyanide treatments was too expensive for large-scale treatments. Another disadvantage of these two materials is that a week to 10 days should elapse between treatment and planting. Headlee (1931) describes a method by which wireworms may be attracted to hills of germinating seeds and destroyed by concentrated charges of either carbon bisulfide or calcium cyanide which also kill the plants.

The preceding methods of control are not satisfactory for New Jersey conditions due to the fact that early planted crops are in the soil and growing before the wireworm attack begins. Therefore, the most desirable control measure is one that may be applied to the plants without injury while they are growing. Burdette (1931) tested reduced charges of CS_2 emulsions carrying pyrethrum extractives, which he applied directly to the infested plants, but the results were inadequate. Burdette (1934) also tested paradichlorobenzene on infested cauliflowers, the results of which showed that in certain types of soil PDB caused injury to the plants while in other soil types the treatment afforded protection to the plants from wireworm injury.

Procedure.—With these reports in mind and the fact that Thomas' (1930) review showed that varying results had been obtained with naphthalene and PDB, the writer thought it advisable to dissolve PDB and naphthalene in carbon bisulfide and in cottonseed oil and test the solutions as emulsions against wireworms. It was found that 1 gallon of carbon bisulfide would readily dissolve 10 pounds of either naphthalene or PDB, whereas a gallon of crude cottonseed oil would dissolve only 2 pounds with heating or long standing.

All experiments were conducted on cabbage, cauliflower and collards. All plants receiving treatment were transplanted in the field and ranged in size from four-leaf seedlings to plants beginning to head. No tests were conducted on young seedlings in the plant beds. With the exception of one-fourth ounce of carbon bisulfide per plant none of the treatments in table 1 caused injury to the plants.

Methods.—The dosages of materials to be used per plant were measured or weighed and the naphthalene or PDB was first dissolved in the solvent, namely carbon bisulfide or crude cottonseed oil. The PDB–cottonseed oil was emulsified in the manner described by Snapp (1932). The carbon bisulfide carrying either of the two crystalline materials was emulsified as follows: 1 ounce of sulfonated castor oil for every 9 ounces of carbon bisulfide to be emulsified was placed in a suitable container, then a small quantity of water was added and the carbon bisulfide was poured in slowly while stirring vigorously. When all the carbon bisulfide had become emulsified, it was diluted with water to the proper volume.

Experiments were conducted in which *Aresklene* (sodium salt of a sulfonated diphenyl compound) was used as the emulsifying agent instead of sulfonated castor oil. One-half ounce of *Aresklene* was used to each 66 ounces of carbon bisulfide to make 100 ounces of a 66 per cent emulsion containing .5 per cent emulsifier.

Experimental plots.—The experiments reported in this paper were made during 1935 and 1936. The wireworm season, however, lasted only about three weeks during each year and the number of replications has been limited. Each experimental plot consisted of 50 plants. In most cases it was necessary to hoe the plants before treatments to keep the liquids from running away from the plants, and to cause them to penetrate deeper into the ground. After hoeing a pint of liquid was applied to each plant. It was found necessary to allow 72 hours to elapse between the treatments and counts. The soil around 10 plants in each plot was examined for insects, taking all the soil for a radius of 4 inches about a plant and 6 inches deep.

Table 1.—Summary of the effectiveness of various emulsions against wireworms.

Plot No.	Treatment and Quantity per Pint per Plant	No. Tests	No. Wireworms Alive	No. Wireworms Dead	Per Cent Wireworms Dead
1	CS_2 ½ oz., naphthalene* 1 gm.	3	29	146	83.4
2	CS_2 ½ oz., PDB 1 gm.	3	21	109	83.8
3	CS_2 ½ oz., naphthalene 1 gm.†	3	12	103	89.4
4	CS_2 ½ oz., PDB 1 gm.†	3	21	121	85.2
5	CS_2 ½ oz., PDB ¾ gm.	3	69	47	40.5
6	CS_2 ½ oz.	2	87	7	7.4
7	CS_2 ½ oz., pyrethrum (alcoholic extract 20:1) 1:200	2	48	8	14.3
8	Pyrethrum (as above) 1:200 plus .5% actual soap	2	62	2	3.1
9	PDB 1 gm. in cottonseed oil	2	21	26	55.3
10	Check, no treatment	3	175	0	.0

* Crude chipped naphthalene.
† Emulsified with *Aresklene*, others emulsified with sulfonated castor oil.

Results.—The data from these experiments have been summarized and are presented in table 1. It should be pointed out, however, that a large number of combinations of chemicals were tested which are not included in this table due to the fact that a poor kill of wireworms was obtained. All combinations presented in table 1 were tested at lower concentrations and were found to be ineffective.

The data are summarized from two and three series of field tests as shown in table 1. The figures from the individual tests were totaled and divided by the number of tests involved. It should also be pointed out that under optimum conditions the kill reached 100 per cent in some cases while under unfavorable conditions the kill was lower than the average given in the table. Factors which may affect the kill are: (a) depth of the wireworms in the soil, (b) temperature of soil, and (c) the condition of the soil around the plants. In loose soil the per cent kill was always higher than in compact soil and was higher in sandy soil than in the heavier clay soils. It is also to be noted in table 1 that there was little difference between naphthalene and PDB in their effects on wireworms. Probably the most interesting point in table 1 is the difference in emulsifying agents, although the difference is not very great, but the *Aresklene* emulsions proved to be slightly better than sulfonated castor oil emulsions in each test. Carbon bisulfide at the rate of one-

fourth ounce per plant, which is twice the concentration of that in the CS_2–naphthalene and CS_2–PDB combinations, was ineffective against the insects and caused injury to the plants. One gram of PDB in cottonseed oil gave a 55 per cent kill without injury to the plants. In other tests, excluded from table 1, in which only enough CS_2 to dissolve the PDB was used, the results are comparable to those in which cottonseed oil was the solvent. The CS_2–pyrethrum combination and pyrethrum–soap combination were ineffective in every case.

Both laboratory and field experiments indicate that soap reduces the toxicity of pyrethrum against wireworms, whereas some of the commercial brands of neutral wetting agents increase its toxicity.

The cost of materials should be taken into consideration in any in-

Table 2.—Comparison of the effectiveness of carbon bisulfide–naphthalene, carbon bisulfide–PDB and nicotine sulfate against onion thrips.

Plot No.	Treatments*	No. Thrips on 5 Plants		Average per Cent Reduction in Population
		July 9	July 16	
1	CS_2–naphthalene	18	14	98.9
2	CS_2–PDB	22	18	98.6
3	Nicotine sulfate 1:600	51	81	95.3
4	Check, no treatment	913	1899	

* Dates of application—July 2, 8, 15.

sect control problem. The cheapest combination in table 1 is CS_2–naphthalene which costs approximately 60 cents per 100 gallons of diluted material. Carbon bisulfide costs approximately 60 cents per gallon, in small lots, as compared to approximately $1 per gallon for crude cottonseed oil. Crude chipped naphthalene costs approximately 3 cents per pound as compared to 16 cents per pound for PDB, while sulfonated castor oil runs approximately 15 cents per pound as compared to 50 cents per pound for *Aresklene*. *Aresklene*, however, would be the cheaper of the two products to use, due to the smaller quantity required.

Onion Thrips, *Thrips tabaci* Lind.—During the summer of 1936, while working on a control for onion thrips, the writer conducted some preliminary experiments with carbon bisulfide–PDB and carbon bisulfide–naphthalene emulsions on small plots. Each plot consisted of two rows 25 feet long.

Two pounds of crude chipped naphthalene were dissolved in 3 pints of carbon bisulfide, which was then emulsified with sulfonated castor oil according to the directions given in the wireworm experiments. This emulsion was diluted to make 100 gallons of spray and potassium oleate was added to the spray to give an actual soap concentration of .25 per cent. These spray combinations were compared with nicotine sulfate 1:600 plus .25 per cent actual soap. The sprays were applied by means of a *Vermorel* knapsack sprayer.

The data from these experiments are set forth in table 2.

As pointed out in table 2, three applications were applied to these plots at weekly intervals. Counts to determine reduction in population were made 24 hours after treatment. It was impossible, however, to get the counts after the first application. From an average of the population of the two counts it can be seen from the table that there were three times as many thrips on the nicotine sulfate plot as on the CS_2–naphthalene or CS_2–PDB plots. The majority of the living thrips on the nicotine sulfate plot were in the crevices of the leaf sheathes, which indicates that the CS_2–naphthalene and CS_2–PDB combinations either had greater wetting power or else liberated gases which killed the insects in the leaf sheaths. Examinations were made from the time the treatments were started until the onions were harvested but no signs of foliage injury from the sprays were noticed. The foliage on the treated plots was in excellent condition while that on the untreated plot showed severe injury by thrips.

The price of the CS_2–naphthalene emulsion is approximately one-third the cost of the nicotine–soap spray.

Summary and conclusions.—Carbon bisulfide–naphthalene emulsions and carbon bisulfide–PDB emulsions have been used on cabbage, cauliflower, collards and onions, at the concentrations mentioned in tables 1 and 2, without injury to the plants. Emulsions containing one-eighth ounce of carbon bisulfide and 1 gram of either PDB or naphthalene, per plant, gave an average of better than 80 per cent kill of wireworms. Carbon bisulfide alone at the rate of one-fourth ounce per plant was ineffective and caused plant injury while 1 gram of PDB in cottonseed oil emulsion gave a 55 per cent kill and was apparently safe on plants. *Aresklene* emulsions of carbon bisulfide appear to be more effective than those made with sulfonated castor oil. The cheapest combination used was carbon bisulfide–crude chipped naphthalene. Carbon bisulfide–naphthalene emulsion was more effective than nicotine sulfate–soap against onion thrips.—3-18-37.

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A slight modification of the Oklahoma quarantine relating to vetch weevil, effective February 20, 1937, provides for a period from January 1 to April 15, during which vetch seed may be shipped into the state from noninfested states east of the Mississippi river. Heretofore the period was from January 1 to April 1. The prohibition applying to shipments from nine eastern states and the District of Columbia remains unchanged.

Experiences with the Termite in New Jersey

THOMAS J. HEADLEE, *New Jersey Agricultural Experiment Station,*[1] *New Brunswick*

Public interest in termites.—As a means of representing, and in some degree measuring, public interest in the termite question the writer has had the New Jersey insect records from 1888 to 1936 inclusive examined. Table 1 sets forth the results.

Table 1 shows sporadic but only slight interest until 1925–1926 when an increase of interest began which has continued to date. All the table means is that in recent years public interest in the termite problem has been increasing at a rapid rate.

Table 1.—Record of inquiries concerning termites.

YEAR	NO. RECORDS	YEAR	NO. RECORDS
1888–1912	1	1924–1925	1
1912–1913	2	1925–1926	6
1913–1914	0	1926–1927	3
1914–1915	2	1927–1928	2
1915–1916	0	1928–1929	3
1916–1917	2	1929–1930	0
1917–1918	1	1930–1931	4
1918–1919	0	1931–1932	22
1919–1920	0	1932–1933	88
1920–1921	0	1933–1934	72
1921–1922	0	1934–1935	218
1922–1923	1	1935–1936	142
1923–1924	0		

It is, of course, interesting and perhaps significant that the great bulk of termite trouble comes from suburban communities where builders have transformed land that was formerly woodland into suburban homes. This fact led to a study of termite infestation under woodland conditions.

Habits under natural conditions.—The general region scouted for location of observation areas was the first and second Watchung mountain ranges west of Bound Brook, N. J. The first range afforded the best conditions, and limited areas were selected upon it. In general, the soil floor is primarily rocky with the usual accumulation of plant debris upon it. Three small areas were selected for observation, each of which measured 100 yards square and contained a trifle over two acres. One such area was chosen in the regular second-growth forest floor, one in a cut-over section and one in a grass section.

The second-growth area was covered mainly with oak, hickory, walnut and some low-growing underbrush. The forest cover formed a fairly dense shade and maintained a cover of fallen leaves sufficient to conserve moisture and to keep the surface soil very moist. Mixed with these decaying leaves were small twigs and branches. Scattered through the area were logs of various sizes from 1 foot in diameter down. Most of these logs had lost their bark.

In the cut-over area all usable timber had been cut and removed within a comparatively recent time. There was an unusually large accumulation of small limbs and branches and of the usual stumps, some of which had been removed entirely and others of which had been pulled out and left on the ground to decay. The soil here contained compara-

[1] Paper of the Journal series, New Jersey Agricultural Experiment Station, Department of Entomology.

tively little moisture and the area was dry, bare and rocky. All the characteristic moist soil and soil cover conditions present in the first area were absent.

Area No. 3 was given over almost entirely to grass with occasionally some low-growing huckleberry bushes and an occasional walnut or oak tree. Apparently this area had been in grass many years and fairly heavy sod had formed. There was present a considerable number of dead limbs and branches.

In area No. 1, which is the forest cover plot, 16 colonies of termites were found. In area No. 2, which is the cut-over area, open to the sun with a limited cover of fallen timber and stumps, no termites were found. In area No. 3 or the grass area, which was covered with grass and interrupted here and there by low huckleberry bushes and an occasional walnut or oak tree, no termites were found.

The obvious difference between these areas is in moisture. All of the area had some wood lying on and in the ground but the cut-over and grass areas were dry whereas the forested area showed plenty of soil moisture under the leaf cover. In the forest area the size of the colony was found to differ very greatly. The number of termites in a colony ranged from a few hundred in small branches and logs to well over 2000 in larger logs.

All colonies were found in fallen timber, both logs and smaller branches lying on the ground. No cut off stumps were found to be infested, neither those in the soil or those which had been recently uprooted.

Search for termites inhabiting living wood was made but no cases were found. The nearest approach to this condition occurred where a dead trunk was still attached to a live stump from which other live trunks issued. Even in such cases the termite burrows were considerably separated from those parts which were alive or transporting nutrients.

In no case was there any evidence of complete destruction of the interior of the log, leaving only the outer shell. This is interpreted to indicate that there was sufficient food in the surrounding area and also that the colonies in the majority of cases do not reach sufficient size to make entire destruction of the interior necessary.

On logs, the bark of which was still present to some extent and infested with termites, there was plenty of evidence of engraver beetle work, although no beetles were taken. Cerambycidae larvae were commonly found in burrows closely adjoining those of the termites. These larvae were identified as *Xylotrechus colonus* and were found quite commonly in oak, hickory and chestnut. Carpenter ants, *Camponotus pennsylvanicus*, were also found occasionally in logs infested with termites although not in very close proximity to the termite burrows. Several species of Carabidae were found close to the soil connection of a termite infested log as well as in the surrounding forest litter. Evidences of fungi and their work were common. No termite nests were found in infested logs and branches, all the timber having been entered from the ground.

Habits in structures.—In the suburban home termites are apt to appear first in poles, posts, blocks of wood and old stumps in the ground. Such infestation gives the householder very little concern, and he has his poles and posts replaced whenever they have, as he says, rotted off.

When, however, the termites appear in a house it is entirely a different matter. In this case his attention is called to the matter by the sudden appearance of swarms of the sexual forms. He wonders where they come from, what they are and what their presence means. Sometimes these sexual forms in heated houses will appear in February when it is too cold outside for insects to be active, and the householder at once concludes that they come from some insect form working in the house itself. Very frequently these winged termites appear in sun porches.

A study was made of the methods of erecting these suburban homes. It was found that concrete block, hollow tile, poured concrete and in a few cases mortar, brick and stone were used for foundations. A cellar had usually been excavated under the house but sun porches and garages were very commonly placed directly upon the soil or a few inches above it. A type of front porch consisting of three face walls, using the house foundation as the fourth, filled in with soil and in many cases partly with wooden debris, and then floored with brick or flagstone, has been very extensively built. The favored elevation of the floor of this type of porch is just below the doorstep. Architects had frequently designed low houses, bringing the timbers within 6 inches of the ground or less, especially on hillsides. Brick or concrete earth-filled steps, rising from the ground to the floor level, have been used in many cases. Posts to support garages have been inserted in the ground and a concrete floor installed around them. Concrete block and hollow tile foundations afford perfect passageways for the termites from the soil to the timbers. The earth-filled porch or steps afford the termite very satisfactory shelter and the crack which develops between the floor and the house wall affords it ready access to the timber. The low setting of the timbers affords the termite a place which it can readily bridge from the soil to the house.

Perhaps one of the more interesting cases which the writer has seen was a wooden house at Summit, N. J., placed on a solid poured-concrete foundation with a completely excavated and concrete-floored cellar. After the wooden portion of the house wall had been completed steel laths were laid from the outside of the concrete foundation up to the eaves and the whole outer surface was plastered with stucco. This layer of stucco extended from the ground surface to the eaves, being plastered continuously over the concrete foundation and over the wire lath on the house sheathing. At the front of the house was placed a circular uncovered and earth-filled porch, the walls and steps of which were brick. The termites came up between this porch and the house wall, made their way through cracks around the door frame under the stucco and had consumed a considerable portion of the timber on one side of the door. Furthermore, with the passage of time the stucco at various places had loosened from the concrete foundation wall and afforded perfect covered passageways for the termite from the ground to the wooden sections of the house.

It seems that people have built their homes in the natural home of the termite and have all unintentionally provided for the termite's persistence by construction which enables the latter easily to enter the structure and secure an endless food supply from the timbers. As a matter of fact it is to this condition that the writer attributes the great

increase in injury to structures in New Jersey with a corresponding increase in public interest in the termite.

Species concerned.—All species which we have received from correspondents or collected in the course of our studies have proved to be examples of the common subterranean termite characteristic of the east coast and known as *Reticulitermes flavipes* Kol. No other species has been taken or received by us.

Prevention.—The building of suburban homes in forested areas of New Jersey has not been finished, but in fact has only well begun. The large part of the termite problem in this state is still to come, and the first step to be taken is the insertion of termite-proof building provisions in the buildings codes of the various boroughs and municipalities in those parts of the state where woodlands are being invaded by suburban buildings. The fundamental principles observed in this building code is the elimination of the termites' means of access to the house.

The writer has on his desk a building code proposition in which occur the following provisions:

SECTION 2. PROTECTION AGAINST TERMITES

1. All major buildings of frame or ordinary construction or parts of buildings of such types of construction shall be protected against damage by termites as hereinafter stipulated.

2. Minor buildings shall be similarly protected when so required by the Building Inspector.

SECTION 3. TYPES OF PROTECTION

1. All buildings required by this resolution to be protected against termites shall be so protected by metal shields, as hereinafter provided, unless foundation walls, cellar floors and all spaces underneath wood floors are constructed with poured stone concrete and the foundation walls where they support wood construction are at least eighteen (18) inches above grade.

2. Where metal shields are used the foundation walls shall not be less than six (6) inches above grade and the walls and floors of cellars and basements may be of such construction as elsewhere provided in the Building Code.

Then follows an extended set of requirements relative to the nature of and the placing of the metal shields.

In this code metal shields are not required if the substructure is made entirely of good rich poured concrete, providing that the said substructure extends at its lowest point at least 18 inches above the outside soil level. In all cases where this type of construction is not used metal shields inserted between the foundation and the wooden superstructures are required. This is, of course, an either/or proposition. It is held by some workers that the metal shield is necessary more or less regardless of the fact that the substructure is of good rich poured concrete, and the ground on which such opinion is held appears to be that concrete construction cannot be made which will be free from cracks. This, it seems to the writer, is not necessarily so, for much has been learned about concrete construction in the course of state highway employment of concrete and it now seems entirely possible to make concrete which will not crack.

This code was made up in the office of a municipality of New Jersey and submitted to the writer for criticism and suggestions.

Control.—The second, and perhaps from the standpoint of public interest the most pressing, problem is control of termite infestations

which have already become established. Here the fundamental principle governing procedure is the same as that which obtains in prevention. Means of access for the termite to the structure from the gound and to the ground from the structure must be eliminated. Chemical treatments of one sort or another are, of course, merely palliatives. It would seem that all things considered the metal shield, in relation to its cost, offers the most permanent cure. Employment of chemically impregnated foundation wood and poisoning of the soil with paradichlorobenzene or orthodichlorobenzene, sodium fluoride and the fluosilicates are less permanent and in some cases more expensive than the shield insertion.

Excavation of cellar space under the house structure is a necessary procedure because the use of known chemicals in such places when not excavated is not only temporary but sometimes dangerous. The most difficult problem of all is the flagstone, bricked-floored, or earth-filled porch. Even here the metal shield probably offers the most permanent and satisfactory solution.

Outlook for future.—There is a possibility of treating the soil beneath and around a structure to be erected so that no termites can live in it, but much more information is needed concerning what materials to use and how to employ them. Such a procedure would probably apply directly to the cure of cases where infestation has already been established.

For the present, at least, it will be necessary to continue with the completely excavated cellar, rich poured-concrete foundation wall and cellar floor, maintenance of the wood structures not less than 18 inches above the surface of the ground at all points, elimination of the earth-filled porch and the substitution therefore of a porch of the same appearance but with a concrete and steel floor and an open passageway for light and air underneath, and the thorough impregnation with creosote of all timbers placed in the ground, whether for fencing, wire supports, arbors, garages or what not.—12 31-36.

Concerning Official Common Names for Insects

W. E. Britton, *New Haven, Conn.*

As the history of common names adopted by the American Association of Economic Entomologists covers a period of nearly a third of a century, it may be well to pause, take readings and soundings and see whether our sailing progress is all in the right direction. Someone even now may ask, "Why do we need common names?" Well, the general public has an aversion to scientific names, is not yet familiar with them and does not know how to use them. So, common names were used for common insects by the common people, and some of these names, such as the codling moth in England, the tent caterpillar and the canker worm in New England, have well-nigh become a part of the folklore of the country.

What are the requisites of an acceptable common name? First, it should be brief, easily spoken, written and remembered. If possible it should convey something distinctive about the insect, such as its appearance, origin or habits. Some common names do not meet these requirements. It is probably best not to encumber a common name with too many adjectives even though they be descriptive ones. Of the common names adopted, many have two and three adjectives, and one four—the round-headed apple tree borer—the first two being joined by a hyphen. In each of the first two adopted lists printed in bulletins of the Bureau of Entomology, there is a footnote stating that these names are radically different from those in use by the Bureau in the matter of hyphenation, and therefore are not authorized by the Bureau.

Common names seem hardly worth while unless generally accepted, approved and used by all entomologists. Appropriate common names that have long been used should not be changed except after the most careful consideration.

At a meeting of this Association in December 1903, a Committee on Nomenclature was appointed to recommend common names for some of the major insect pests and certain beneficial and striking insects. It was felt that if such names could be selected, adopted and used by all entomologists, that much confusion might be avoided. It was suggested that eventually common names might be adopted for about 1000 species of insects. Later the name of this committee was changed to Committee on Common Names.

A year later (December 1904) this committee recommended for trial, a list of 60 common names (*1*). On January 1, 1906, 102 names were adopted by the Association (*2*). December 28, 1906, 40 additional names were adopted (*3*). Both these lists were combined and printed in the new JOURNAL OF ECONOMIC ENTOMOLOGY (*4*). On December 28, 1909, 52 more names were adopted (*5*). December 29, 1911, two names were adopted (*6*). Then there is either a skip in the records or a period of inactivity on the part of the committee. On December 26, 1918, four names were adopted (*7*), and on December 31, 1919, 40 names (*8*).

At the annual meeting in December 1922 the committee presented rules concerning common names (*9*), which were adopted by the Association, and two years later revised and additional rules and a new list of 633 common names were adopted and published (*10*). In December 1925 the Association adopted 63 names (*11*) and in December 1926, 42 names (*12*). There were also adopted in December 1927 eight more names (*13*); in December 1928 three names (*14*); and in December 1929, 23 names (*15*).

In December 1930 further names were submitted for approval but the number seems not to be a matter of record. However, some names formerly adopted were changed and the revised list of common names of 865 species (*16*) was printed. Separates were issued and sold and this list has been used by entomologists for the past five years. In December 1932 a list of 71 names was submitted by the committee, and 28 of them were adopted by the Association (*17*).

In general the 1931 list of common names in the form of a separate has proved very helpful and is in constant use in my own department.

However, a few names appeared in this list for the first time that are open to question, and I will mention some of them here.

Chionaspis pinifoliae—"Pine needle scale." This species was described by Dr. Asa Fitch 80 years ago, and he called it the "pine leaf scale insect." It has commonly been called the "pine leaf scale," and so far as I know has had no other common name. It is true that pine leaves are called "needles" but in reality they are leaves instead of needles, they function as leaves and are called "leaves" in the manuals of botany. It would seem desirable to change back to the shorter and generally accepted common name.

Sitodrepa panicea—"Drug-store weevil." This beetle belongs to the family Anobiidae, is not a weevil, and should not be called a weevil. Why not call it the "drug-store beetle," a name that occurs in most of the literature dealing with this insect?

Anthrenus verbasci—"Varied carpet beetle." This beetle has often been called the "museum beetle," a shorter and more distinctive name. Although it may feed upon any dried animal fibers or integument, it is distinctly the most troublesome pest in our insect collections.

Malacosoma americana—"Eastern tent caterpillar." This insect has been called several names, but in the 1931 list, for the first time, it is called the "eastern tent caterpillar," presumably to differentiate it from the western tent caterpillar and the California tent caterpillar. I wonder if this is necessary. Why not just "tent caterpillar"?

Papilio polyxenes is given three common names—"parsley worm" and "celery worm" for the larva, and "black swallowtail" for the adult. *Hamadryas antiopa* has only one common name, the "mourning-cloak butterfly." It would seem desirable to assign another common name to the larval stage, such as the "spiny elm caterpillar."

Since the 1931 list was published, 11 names previously adopted have been changed, and three of these changes are not approved by my department. These are as follows:

Anomala orientalis, first discovered in this country in Connecticut in 1920, and identified in 1922, was called the "Asiatic beetle," a name officially adopted and printed in the 1931 list. Someone in Washington suggested that this name be changed to "Oriental beetle" to avoid confusion with *Autoserica castanea*, an insect first discovered in New Jersey in 1921 and later in New York, finally identified in 1926, and called the "Asiatic garden beetle." Of course both species are of oriental and Asiatic origin. "Asiatic beetle" for *Anomala orientalis* was used long before *Autoserica castanea* was identified, and was used many times in the literature of economic entomology over a period of 10 years. The name "Asiatic beetle" therefore had not only priority but an established usage, and it may fairly be claimed that changing it to "Oriental beetle" will make greater confusion than to find a different name for *Autoserica castanea*.

Pineus strobi, formerly *Adelges pinicorticis*, has long been known as the "pine bark aphid," a name seemingly far preferable to that of "pine bark louse," as the term "louse" should be reserved for the Pediculidae and Mallophaga, and not applied to aphids.

Scolytus rugulosus has long been called "shot-hole borer" and "fruit

bark beetle"; "fruit tree engraver" seems to be no improvement but will tend to make greater confusion.

During the last year a list of common names for 136 species of insects was submitted for approval and a new list will soon be published. The entomologists of my department felt obliged to vote against about a dozen of these names and the reasons for their objections are as follows:

Adelges abietis—"Eastern spruce gall aphid." This is a European species that may occur wherever its host trees are grown. Why "eastern"?

Adelges cooleyi—"Cooley's spruce gall aphid." It has been known as the "Sitka spruce gall aphid" and the "blue spruce gall aphid." "Cooley's spruce gall aphid" does not seem to be an improvement over the other names.

Adelges piceae—"Fir bark louse." This name meets the same objections as "pine bark louse" for *Pineus strobi*. "Fir bark aphid" is preferable.

Callidium antennatum—"Black-horned pine borer." The antennae are not blacker than in some other species of *Callidium*.

Calomycterus setarius—"Imported long-horned weevil." Apparently the antennae of this species are not longer than in some other weevils, particularly *Balaninus*. The term "long-horned" is not usually applied to the Curculionidae and may tend to confuse it with the Cerambycidae.

Chrysomphalus dictyospermi—"Dictyospermum scale." This species has been called "Morgan's scale," a shorter name.

Culex pipiens—"Northern house mosquito." This is known here as the "rain barrel mosquito" or "house mosquito." According to Dyar (Mosquitoes of the Americas) it occurs north of the 38th parallel of north latitude, and also in South America, south of the 39th parallel of south latitude.

Mansonia perturbans—"Irritating mosquito." "Irritating" is a term that can be applied to any biting species and therefore is not distinctive. The alternative, "Manson's mosquito," seems preferable.

Psorophora ciliata—"Shaggy-legged gallinipper." "Giant mosquito" seems preferable because briefer and more easily understood.

Drosophila spp.—"Vinegar flies." They have long been known as "fruit flies," a shorter name. Moreover they do not breed in vinegar but in any fermenting plant material where yeast is present.

Fenusa pumila—"European birch sawfly." *Phyllotoma nemorata*—"Birch leaf-mining sawfly." Both are of European origin, both are sawflies and both are leaf miners of birch. *Fenusa pumila* was the first of the two to be studied in America, and an account of its life history, habits and morphology has been published as the Birch Leaf-Mining Sawfly, by Dr. R. B. Friend (*18*). It may eventually be necessary to designate them as the "Fenusa birch sawfly" and the "Phyllotoma birch sawfly." At any rate the names proposed do not seem acceptable.

Mr. Hyslop wrote that the committee had concurred in all my objections and ruled out the proposed names except the "northern house mosquito" and "dictyospermum scale."

All of the foregoing leads up to the chief point that I wish to make. We should make haste slowly in selecting common names. It is neither

necessary nor desirable that every species of insect have a common name. We should not strain ourselves to originate them. Wait until an appropriate name comes easily, something that fits, something that will stick.

If a member wishes to propose a common name he should first read the rules. Probably the committee should first reject some of the names as unsuitable before submitting the list to members for ballot. On each list there are insects from some other portion of the country and with which a member is unfamiliar. He does not feel qualified to pass upon such species and votes neither for nor against the names proposed, yet unless 20 per cent or more of the votes cast are in opposition to any name, that name is considered approved. Perhaps there should be room on the blank to indicate reasons for objections or approval.

Finally, I believe that common names should be as simple as possible. Otherwise they defeat their purpose. The Association should not take any action that will make "confusion worse confounded." If a common name is more cumbersome than the scientific name, then, for Heaven's sake, let's use the scientific name!—11-30-36.

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(*8*) *Ibid.* **13**(1): 12. 1920.
(*9*) *Ibid.* **16**(1): 22. 1923.
(*10*) *Ibid.* **18**(3): 522. 1925.
(*11*) *Ibid.* **19**(5): 797. 1926.
(*12*) *Ibid.* **20**(6): 838. 1927.
(*13*) *Ibid.* **21**(1): 25. 1928.
(*14*) *Ibid.* **22**(5): 825. 1929.
(*15*) *Ibid.* **23**(3): 639. 1930.
(*16*) *Ibid.* **24**(6): 1274. 1931.
(*17*) *Ibid.* **26**(6): 1169. 1933.
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AMERICAN ASSOCIATION OF ECONOMIC ENTOMOLOGISTS

PAPER-READING SESSION, FORTY-EIGHTH ANNUAL MEETING

St. Louis, Mo., December 1935

Influence of Size of Brood Cell upon Size and Variability of the Honeybee[1]

Roy A. Grout,[2] *Hamilton, Ill.*

Baudoux (1927) in Belgium was the first to conceive the use of an artificial foundation having an enlarged cell base to increase the size of the emerging worker bee. Independent of the work done by Baudoux, Pincot, according to Gillet-Croix (1927) carried out similar experiments. While the data presented by them have not been of a very scientific nature, each claimed larger bees resulting in a greater yield of honey. Their contentions have been convincing to the extent that manufacturing houses in Belgium and France and more recently in Italy and England are making foundations having larger cell bases and claiming better

[1] Journal paper J324 of the Iowa Agricultural Experiment Station, Ames, Iowa; project No. 129.
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results through its use. Consequently, interest in this country has been focused upon this matter.

Lovchinovskaya (1930) of Russia, reporting investigations started in 1925, concluded that bees from enlarged cells weighed more, that they had a greater load capacity, and that from the results of one season, they produced more honey.

During the period 1930–32, the first biometrical study was made to determine whether bees reared in large cell foundation were larger and to study the variability of the emerging worker bees. These experiments were carried on at Iowa State College under the direction of Dr. O. W. Park.

Three sizes of foundation were used in this experiment, having respectively 857, 763 and 706 cells per square decimeter. The foundation having 857 cells per square decimeter is the commercial size manufactured in the United States while the two latter sizes closely approximate that having 750 cells per square decimeter which has been manufactured since 1896 by Jos. Mees Sons of Herenthals, Belgium, and that having 700 cells per square decimeter manufactured by the same firm since 1927.

The foundation used in this experiment was furnished by Dadant & Sons, Hamilton, Ill. The sheets of foundation, containing 10 vertical wires, were placed in a frame containing four horizontal wires, eliminating all warp and sag in the finished comb. No control of size of cell other than size of foundation was exercised.

To facilitate recognition and handling of the combs, and for convenience in presenting data, the frames containing the standard size foundation, that having 857 cells per square decimeter, were marked *A* and the cell size was referred to as size of cell *A*. Similarly, frames containing foundation having 763 cells per square decimeter were marked *B* and the cell size was referred to as size of cell *B*, and the frames containing foundation having 706 cells per square decimeter were marked *C* and the size of cell was referred to as size of cell *C*.

Two frames of each size of foundation were placed in the same colony. Individual colony records were kept and the queens were marked by clipping the right wing of those reared in an even-numbered year and the left wing when reared in an odd-numbered year.

It is of interest to mention that difficulties were experienced in getting the queens to oviposit worker eggs in the enlarged cells when all three sizes were placed in the same hive at the same time. This was particularly true in case of size of cell *C*. While the worker bees apparently recognized no difference in accepting the three sizes of cells, the queen bees showed a preference for the smaller cells for ovipositing. This result is confirmed by similar experiments carried out by Lovchinovskaya (1930).

An effort was made to collect the bees upon emergence from all three sizes of cells in a single colony at approximately the same time and under the same conditions. To determine the date of emergence, a chart was used whereby the daily emergence of bees from 23 colonies was recorded. Prior to emergence, each frame was caged in a Root introducing cage and a selected area of brood containing no nectar or honey was caged with an additional screen cage.

Each sample of bees contained at least 50 specimens. Following the

method outlined by Alpatov (1929) the bees were slightly anaesthetized and then killed by dropping into boiling water. They were then preserved in a 70 per cent alcohol solution to await further treatment. The measurements taken on each individual bee were dry weight, length of right fore wing, width of right fore wing, the sum of the widths of the third and fourth tergites and the length of proboscis.

After taking the dry weight of each individual bee, the parts were

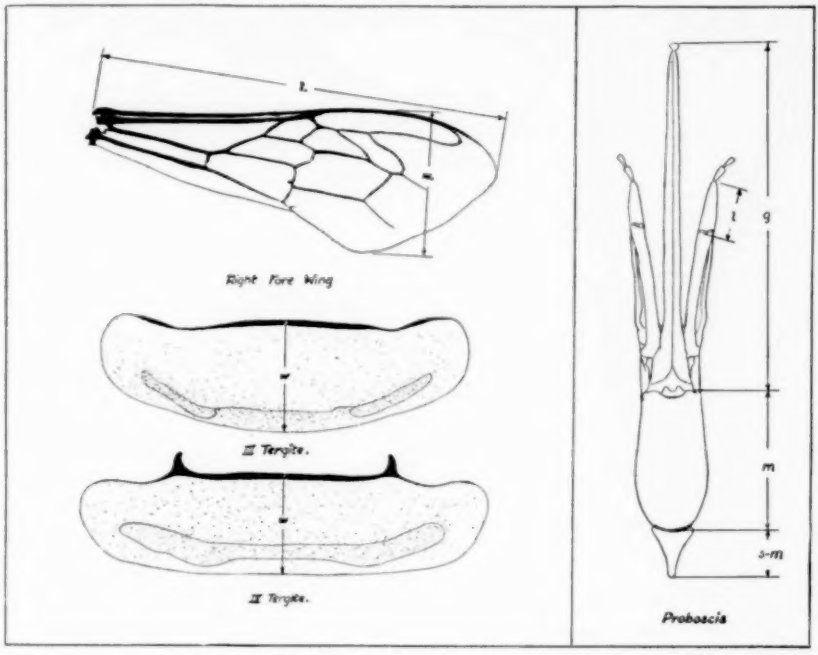

Fig. 1.—*A*, measurements taken on the right fore wing, and on the third and fourth tergites of the honeybee; *l*, length of wing; *w*, width of part. *B*, measurements taken on proboscis of the honeybee; *g*, length of glossa; *m*, length of mentum; *s–m*, length of submentum; $g+m+s-m$, length of proboscis.

dissected and temporary mountings were made on glass slides. These slides were placed in a Leitz simple micro-projector, in a vertical position and projected onto a movable screen containing on its face both a vertical and a horizontal scale. The apparatus was adjusted so that a glass Spencer stage micrometer having a 2 mm. scale ruled to .01 mm. gave a corresponding reading on the movable screen magnified 127 times. I want to take this opportunity to recommend this method of making extensive measurements of this type as being easy, rapid and accurate.

Computations were made for three groups of bees from each of three colonies. The statistical computations were accomplished by recording the values of the measurements of each bee on a *Holerith* punched card. These cards were sorted by a *Holerith* sorter and run through a *Holerith*

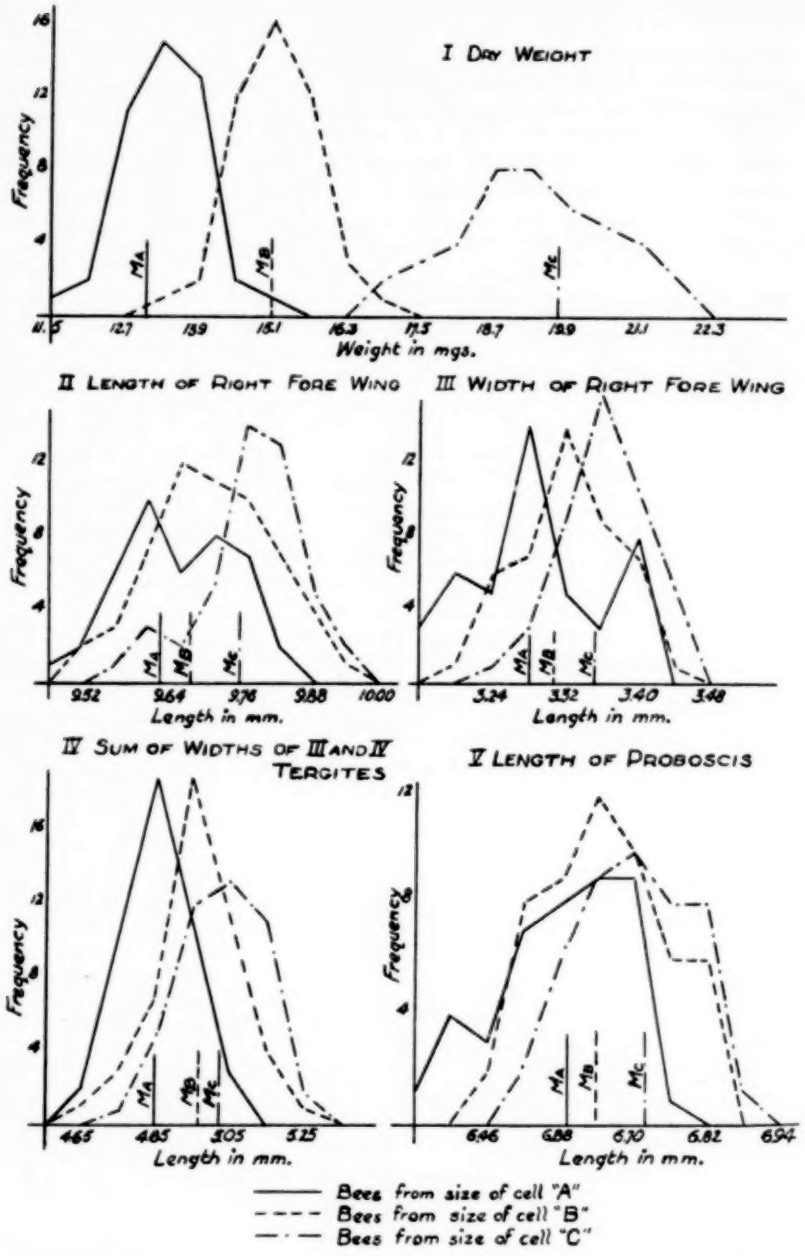

Fig. 2.—Frequency curves of various characters in bees from cells of sizes *A*, *B*, *C*.

Electric Tabulating and Accounting Machine. From the summations obtained, the arithmetic means, standard deviations, correlation coefficients, regression equations and other statistical constants were computed. All statistical formulae and methods used are given by Wallace & Snedecor (1931).

Figure 1, A, shows the measurements taken on the right fore wing, the third tergite and the fourth tergite. Figure 1, B, shows the measurements taken on the proboscis. In each case a reading was taken at the beginning and at the end of the part, the difference being its measurement. For further statistical treatment, the length of submentum, mentum and glossa were all recorded.

Table 1.—Influence of size of cell upon size of bee, colony 25.

Measurement Taken	Size of Cell A M ± δ M.	Mean Diff. of A and B M.D. ± δ M.D.	Size of Cell B M ± δ M.	Mean Diff. of B and C M.D. ± δ M.D.	Size of Cell C M ± δ M.	Mean Diff. of A and C M.D. ± δ M.D.
Dry weight in mgs.	13.1 ± .0939	2.0302* ± .1427	15.1302 ± .1075	4.6876* ± .296	19.8178 ± .2758	6.7178* ± .2913
Length of right fore wing in mm.	9.6075 ± .0229	.0578* ± .0277	9.6653 ± .0155	.0856* ± .0234	9.7509 ± .0175	.1434* ± .0288
Width of right fore wing in mm.	3.2836 ± .0109	.0345* ± .0141	3.3181 ± .009	.0381* ± .012	3.3562 ± .0079	.0726* ± .0135
Sum of widths of third and fourth tergites in mm.	4.8545 ± .0148	.1087* ± .0223	4.9632 ± .0167	.0721* ± .0235	5.0353 ± .0165	.1808* ± .0222
Length of proboscis in mm.	6.3916 ± .019	.0614* ± .0224	6.453 ± .0118	.075* ± .0188	6.528 ± .0146	.1364* ± .024
Length of mentum in mm.	1.7477 ± .0062	.0261* ± .0082	1.7738 ± .0053	.002 ± .0079	1.7758 ± .0059	.0281* ± .0086
Length of glossa in mm.	4.2832 ± .0147	.0517* ± .0172	4.3349 ± .009	.0531* ± .0152	4.388 ± .0123	.1048* ± .0192
Length of glossa and mentum in mm.	6.0316 ± .0164	.0771* ± .0196	6.1087 ± .0107	.0551* ± .0175	6.1638 ± .0138	.1322* ± .0214

* Mean difference is statistically significant.

Bees from colony 25.—Figure 2, graph I, is a frequency diagram of the character dry weight. Each curve represents the frequency distribution of the bees from each size of cell. We note that not only do the arithmetic means and peaks of its curves differ widely, but also the distribution, since the curves scarcely overlap.

Figure 2, graph II, is a frequency diagram of the character length of right fore wing. Here we note a trend in the peaks of the curves and in the arithmetic means showing a tendency toward a greater length of right fore wing as the size of the cell is increased. The curves, however, overlap showing less difference in the distribution. This is to be expected since the character dry weight is a measurement of mass and consequently volume. Graph III is a frequency diagram of the character width of right fore wing. Graph IV shows the frequency distribution of the character sum of the widths of the third and fourth tergites. Graph V is a frequency diagram of length of proboscis.

Although we fail to find marked differences in the distribution curves, we note that there are distinct differences in the means.

Table 2.—Per cent increase of measurements as size of brood cell increases, colony 25.

Measurement Taken	Per Cent Increase from A to B	Per Cent Increase from B to C	Per Cent Increase from A to C
Dry weight	15.5	30.98	51.27
Length of right fore wing	.6	.89	1.49
Width of right fore wing	1.05	1.15	2.21
Sum of widths of third and fourth tergites	2.24	1.45	3.72
Length of proboscis	.93	1.13	2.07
Length of mentum	1.49	.11	1.61
Length of glossa	1.21	1.22	2.45
Sum of lengths of mentum and glossa	1.28	.9	2.19
Average of seven linear measurements	1.37	1	2.38
Diameter of cell	5.98	3.96	10.18

Table 1 gives the arithmetic means of the five measurements, the standard deviation of the means, and the mean differences with their standard deviations. Those values of mean differences which meet the test for significance are starred. It will be noted that in all cases, the mean differences of the measurements of bees from size of cell *A* and size of cell *B* are significant. The difference between the means of the measurements of bees from size of cell *B* and size of cell *C* are significant except for the character length of mentum. As one would expect, the mean differences between bees from size of cell *A* and size of cell *C* are all significant.

In table 2 are presented the per cent increases of all the measurements taken. It is of interest to note that the length of proboscis increased 2.07 per cent as the size of foundation was increased from 857 to 706 cells per square decimeter. Comparison of the average per cent increase of all the linear measurements to the per cent increase in the diameter of the cells shows an increase of 1.37 per cent as the diameter of the cell increases 5.98 per cent, an increase of 1 per cent as the diameter of the cells increase 3.96 per cent, and a total increase of 2.38 per cent as the diameter of the cells increase 10.18 per cent. The ratio between these per cent increases is fairly constant.

Bees from colony 18.—In table 3 are presented data concerning the increase in the size of the worker bees from colony 18 as shown by the

Table 3.—Influence of size of cell upon size of bee, colony 18.

Measurement Taken	Size of Cell A M.±δM.	Mean Diff. of A and B M.D.±δM.D.	Size of Cell B M.±δM.	Mean Diff. of B and C M.D.±δM.D.	Size of Cell C M.±δM.	Mean Diff. of A and C M.D.±δM.D.
Dry weight	16.102 ±.2054	−.7895* ±.2422	15.3125 ±.1284	1.6115* ±.1542	16.924 ±.0854	.8220* ±.2224
Length of right fore wing	9.639 ±.0241	−.0619 ±.036	9.5771 ±.0268	.1531* ±.0322	9.7302 ±.0178	.0912* ±.02996
Width of right fore wing	3.321 ±.0113	.0094 ±.0146	3.3304 ±.0093	.014 ±.0123	3.3444 ±.008	.0234 ±.0138
Sum of widths of third and fourth tergites	4.9212 ±.0187	.0063 ±.026	4.9275 ±.0181	.0605* ±.0276	4.988 ±.0208	.0668* ±.028
Length of proboscis	6.5778 ±.0166	.013 ±.0314	6.5908 ±.0266	.0794* ±.0305	6.6702 ±.015	.0924* ±.0224

* Mean difference is statistically significant.

Table 4.—Influence of size of cell upon size of bee, colony 21.

Measurement Taken	Size of Cell A M. ± δM.	Mean Diff. of A and B M.D. ± δM.D.	Size of Cell B M. ± δM.	Mean Diff. of B and C M.D. ± δM.D.	Size of Cell C M. ± δM.	Mean Diff. of A and C M.D. ± δM.D.
Dry weight	15.735 ± .1654	−.2443 ± .2694	15.4907 ± .2127	.4449 ± .2456	15.9356 ± .1228	.2006 ± .206
Length of proboscis	6.671 ± .0183	.0741* ± .0235	6.7451 ± .0148	.0269 ± .0195	6.772 ± .0127	.101* ± .0227
Length of right fore wing	9.693 ± .0227	.1442* ± .029	9.8372 ± .0181	.0657 ± .0333	9.9029 ± .028	.2099* ± .036
Width of right fore wing	3.3093 ± .0133	.0474* ± .0155	3.3567 ± .0079	−.0003 ± .0146	3.3564 ± .0123	.0471* ± .0181
Sum of widths of third and fourth tergites	4.9938 ± .0169	.1611* ± .0282	5.1549 ± .0226	.0253 ± .0282	5.1802 ± .0169	.1864* ± .0239

* Mean difference is statistically significant.

arithmetic means of the measurements and their differences. The mean differences of the measurements on bees from size of cell *A* and size of cell *B* show only one significant difference, this being in the case of dry weight and in a negative direction. In regard to measurements on bees from size of cell *B* and size of cell *C*, there are significant mean differences for each character except width of the right fore wing. The same conclusion is true concerning the differences between the means of measurements on bees from size of cell *A* and size of cell *C*.

Bees from colony 21.—The arithmetic means and the mean differences of measurements taken on bees from colony 21 are shown in table 4. Differences between the means of measurements on bees from size of

Table 5.—Correlation coefficients of bees from colony 25.

Measurement Taken	Size of Cell	Length of Right Fore Wing	Width of Right Fore Wing	Sum of Widths of Third and Fourth Tergites	Length of Proboscis	Length of Glossa	Length of Mentum	Sum of Lengths of Mentum and Glossa
Dry weight	A	+.4738*	+.4253*	+.3873*	+.4460*	+.3410†	+.3135†	+.4227*
	B	+.3217*	+.3780*	+.2242	+.0919	−.0483	+.0378	+.0191
	C	+.3135*	+.2674	+.3354†	+.1939	−.0591	+.2634	+.0596
Length of right fore wing	A		+.7095*	+.3011†	+.7274*	+.6902*	+.3538†	+.7404*
	B		+.4427*	+.2108	+.2818	+.2934†	+.2258	+.3582†
	C		+.6312*	+.3635†	+.6297*	+.5216*	+.3324†	+.6086*
Width of right fore wing	A			+.2444	+.4716*	+.3713*	+.4060*	+.4887*
	B			+.1164	+.1776	+.0861	+.3314†	+.2371
	C			+.1831	+.2918	+.3113*	+.1121	+.3264†
Sum of widths of third and fourth tergites	A				+.2120	+.2559	−.0886	+.1991
	B				−.1406	−.0476	−.0733	−.0764
	C				+.2241	+.1900	+.2124	+.2607
Length of proboscis	A					+.3977*	+.9091*	+.9547*
	B					+.4967*	+.8487*	+.9546*
	C					+.5570*	+.7881*	+.9430*
Length of glossa	A						+.0682	+.4311*
	B						+.0288	+.5219*
	C						+.1835	+.3121†
Length of mentum	A							+.6565*
	B							+.8838*
	C							+.8355*

* Correlation coefficient is highly significant. † Correlation coefficient is significant but not highly so.

cell *A* and size of cell *B* are all significant except for the character dry weight. There are no significant mean differences between the means of bees from size of cell *B* and size of cell *C*. The mean differences of measurements on bees from size of cell *A* and size of cell *C* show significant increases except for the character dry weight.

Variability of worker bees from colony 25.—From the data presented in tables 1, 3 and 4 it is evident that the samples of bees from colony 25

Table 6.—Statistical constants of bees from colony 25. Correlation of (A) dry weight, (B) length of right fore wing, (C) width of right fore wing, and (D) sum of the widths of the third and fourth tergites on (X) length of proboscis.

Statistical Constant	Sign	Size of Cell A	Size of Cell B	Size of Cell C
Standard deviations of samples	δA	± .6228	± .7372	± 1.8502
	δB	± .1513	± .1062	± .1173
	δC	± .0721	± .0616	± .0530
	δD	± .0985	± .1144	± .1109
	$\delta\times$	± .1263	± .0807	± .0982
Standard regression coefficients	$\beta\times$A	+.1587	+.0216	+ .0145
	$\beta\times$B	+.7481*	+.2910†	+ .7448*
	$\beta\times$C	−.1154	+.0657	− .1788
	$\beta\times$D	−.0464	−.2144	− .0187
Multiple correlation coefficient	R	+.7422*	+.3540	+ .6445*
Standard error of estimate	$\delta\times\cdot$ABCD	± .0889	± .0790	± .0787
Significance of regression	Z	1.2406*	.2064	.9804*

Regression Equations

A. X = .3218 A + .6244 B − .2021 C − .0595 D + 1.1235
B. X = .0236 A + .2211 B + .0860 C − .1512 D + 4.9453
C. X = .0077 A + .6232 B − .3315 C − .0165 D + 1.8315

* Correlation coefficient is highly significant. † Correlation coefficient is significant but not highly so.

are more homogeneous than samples of bees from colonies 21 and 18. The following study of the variability of the worker bee as influenced by size of brood cell will be concerned with the bees from colony 25.

In table 5 are presented the correlation coefficients, with those values which are highly significant and those values which are significant but not highly so, differentiated. An examination of these values shows that the character dry weight is inconsistent in its correlation and in general correlates poorly with the other characters. From these and other data, we infer either that further experimental control should be exercised in the measurement of this character or that it does not correlate with the other characters. The sum of the widths of the third and fourth tergites correlates poorly. There is a highly significant correlation between wing length and tongue length and wing length and wing width. Length of proboscis correlates significantly with its integral parts. These data substantiate the methods of both Merrill (1922) who measured only the glossa, and Michailov (1927) who used the entire length of proboscis in their computations.

In tables 6 and 7 are presented other statistical constants. An examination of the standard deviations shows that there is no consistency in the variation of measurements on bees from the three different sizes of cells except in the case of length of proboscis and wing length, in which the greatest variation occurs in bees from size of cell *A* with the least varia-

tion occurring in bees from size of cell *B*. These data appear to corroborate those of Kellogg (1906), who stated that while drone bees reared in worker cells varied more than their drone cell brothers this variation was not due to size of cell.

An analysis of variance further substantiates the significance of the differences between the means given in table 1, showing that there is a greater variation between groups than there is within the various groups. The regression coefficients substantiate the significance of the multiple correlation coefficients, showing that the regression of the measurements on bees from size of cell *A* and size of cell *C* has been accounted for significantly. In regard to the regression equations presented in table 6,

Table 7.—Statistical constants of bees from colony 25. Analysis of variance of length of proboscis of A, B and C groups.

Source of Variation	Degrees of Freedom	Sum of Squares	Mean Square or Variance	Standard Deviation	Natural Log. of S.D.
Between groups	2	4,251.81	2125.90	46.1075	3.830977
Within groups	133	14,096.02	105.99	10.2951	2.331667
Total	135	18,347.83	135.91	11.6580	1.499310
		$Z = 1.4993$*			

* Correlation coefficient is highly significant.

it is of extreme interest to record that length of right fore wing appears to be the dominating factor in these estimation equations of length of proboscis.

Discussion.—From the data presented we conclude that size of brood cells is a factor in determining the size of the adult worker bee and that significantly larger bees are obtained through the use of artificial foundation having an enlarged cell base. The size of the brood cell apparently does not affect the variability of the various measurements. It is evident, however, that size of cell alone is not sufficient to produce a much larger bee. It is reasonable to state that selection and breeding of bees plus the application of extrinsic factors such as size of cell should accomplish marked results in this direction.

The inconsistencies arising in the data presented in this paper can be attributed only to random selections from a large population and possibly to experimental treatment of certain material. Spurious correlations contribute to some of the peculiarities of the correlation coefficients. It is believed that the use of samples containing a larger number of bees selected from each size of cell would strongly tend to give consistently significant results. This opinion substantiates that of Phillips (1929), who discounted the work of Merrill (1906), who calculated that it was necessary to examine only 40 bees from a colony in order to determine which colony would produce the most honey.

From the data here presented, we cannot agree with Baudoux (1927), either in the results he obtained or the consistency of them. While Baudoux reports an increase of 11.9 to 25 per cent in length of proboscis as the size of the brood cell increases from 850 cells per square decimeter to 700 cells per square decimeter, we are able to record increases

of only 2.07, 1.51 and 1.40 per cent for colonies 25, 21 and 18 respectively.

These results, however, compare favorably with an increase of 4.82 per cent obtained by Michailov (1927) in measuring the proboscides of worker bees reared in worker cells as compared with those of worker bees reared in drone cells. It also compares favorably with results obtained on worker bees reared in new combs as compared with worker bees reared in old combs. Here Michailov records an increase of 1.05 per cent in the length of proboscis.

From a combined study of the correlation coefficients and standard deviations of measurements taken on bees from colony 14, it is shown that the second member of the right labial palpus is not related to length of proboscis and does not vary with it. Consequently, the author cannot agree with conclusions of Götze (1930), who obtained a judgment of the relative length of proboscis from the measurement of this member and described a formula for estimating length of proboscis from it.

From the data presented in this paper, it appears that length of right fore wing and width of right fore wing would be more suitable for use in estimation equations of length of proboscis. In addition to the fact that they correlate significantly with length of proboscis and tend to vary with it, they are easier to dissect and measure.

Summary.—Size of brood cell affects the size of the adult worker bee and significantly larger bees are obtained through the use of enlarged cell foundation.

Size of brood cell is not sufficient to produce a much larger worker bee.

Size of brood cell apparently does not affect the variability of the adult worker bee.

Length of right fore wing and width of right fore wing tend to give the best estimation of length of proboscis.—3-15-37.

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Method for Determining Amount of Mineral Oil Deposited on Orange Leaves Immediately after Spraying

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During the course of experimental work on the deposit of emulsified oil on various artificial surfaces, it was found advisable to develop a check method whereby the deposit of these emulsions could be tested on foliage.

One of the first essentials of the method was that it be rapid so that results could be obtained quickly and there would be no necessity of waiting for the foliage to dry, or for extractions to be made in order to dissolve the oil out of the leaf tissue.

Various methods for determining oil deposits on foliage have been presented by other workers. English (1930) presented a method which consisted of taking samples of 50 leaves after the spray had dried and punching disks 10 square centimeters in area from each leaf. The oil was extracted from the leaves with ether by shaking the mixture of leaves and ether in a tightly stoppered bottle. The ether solution after filtering was concentrated to a volume of 20–25 cubic centimeters. This solution was then floated on a .5 normal sulfuric acid in a Babcock skim milk bottle, the ether being driven off at 50° C and the temperature gradually raised to 80° C. Hot sulfuric acid of the same concentration was then added until the bottle was nearly full. The mixture was centrifuged while hot and the reading finally taken, with dividers, from the capillary tube of the bottle.

Swain & Green (1933) washed the oil from the surface of leaves with methylene chloride after the spray had dried. The solvent was evaporated on a water bath at 45° C, the dish then heated in an oven at 45–50° C for two hours, cooled and weighed to determine the amount of oil.

Dawsey & Haas (1933) used an ether extraction method. One hundred disks 30 mm. in diameter cut from the leaves were used for each sample. Each sample was extracted for one minute with 50 cc. of ether and washed twice with two 25 cc. portions of ether. The washing was evaporated to dryness and redissolved in a mixture of ether and absolute alcohol. Wax from the leaves was precipitated at −30° C and filtered off with a special filtering apparatus. The oil was treated with concentrated nitric acid in a Babcock skim milk bottle and the oil column measured in the neck of the bottle after centrifuging.

Rohrbaugh (1934) ground dried, sprayed citrus leaves in a Wiley mill

[1] Contribution from research laboratories. Early publication has been secured by payment of the printing charge.

and extracted the oil with petroleum ether (boiling point 30–60° C) by soaking the mixture in a flask for 30 minutes with shaking at five-minute intervals. The solution was filtered and evaporated to 5 cc. at 60–65° C. The mixture was then digested with sulfuric acid after which it was transferred to a Babcock bottle and centrifuged, the oil column being measured 30 minutes after centrifuging.

Although the method developed for use in this work employs the general principles of some of the previously mentioned methods, it is essentially different in most details and was proved to be very accurate with no interference from plant waxes or essential oils.

Technic of method.—This method differs primarily from the others in that the oil and water are washed from the leaves immediately after spraying, as soon as run-off has ceased. The solvent used, acetone U.S.P. being a mutual solvent for oil and water, these substances may be washed from the leaves simultaneously and the water and acetone evaporated off together.

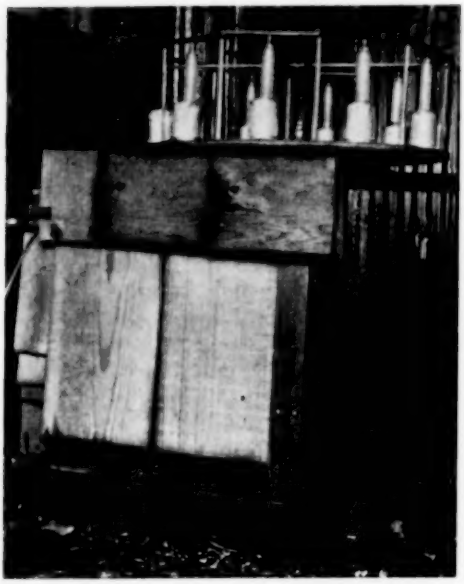

Fig. 1.—Turntable used in making spray deposit tests. Leaves were pinned to the upper horizontal bars between the bottles, one leaf in each interspace.

The leaves used for this work were mature orange leaves, mostly of the Valencia variety. No difficulty was encountered in washing the oil from the leaves and recovering it but it was necessary to ascertain that no oil was lost and that there was no contamination by the plant waxes or essential oils during any part of the procedure. These points, as well as others which came up, were definitely worked out as the procedure was developed.

The entire technic and procedure for the determination is as follows:

Twenty mature orange leaves, average size an area of about five square inches on one side (10 square inches on both sides), are removed from the tree by grasping the stem between the thumb and forefinger, thus breaking it off at the base and removing stem and leaf intact. The leaves are placed in a clean dry dish as they are picked and left there until hung up for spraying. For exposure to the spray the leaves are fastened to a turntable 10 feet from the spray nozzle by pinning them through the stems, (fig. 1). To prevent the leaves being blown about by the stream of spray, the tips are held by small battery clips which are fastened to the base of the turntable with small rubber bands.

After spraying, the leaves are removed by unfastening the clips and pulling out the pins. The leaf which remains on the pin is grasped by the stem as the pin is pulled out. The tips of the leaves are cut off with small scissors, then the stems. As the leaves are cut from the stems they are allowed to fall into a "washing dish" of glazed porcelain 17 by 11 by 3 cm. in dimension. The leaves are taken into the laboratory in this dish and by means of forceps are transferred to a glass evaporating dish. This dish is 10.5 cm. wide at the top. 4.5 at the bottom and 5.5 cm. deep, with a capacity of 300 milliliters. As soon as the leaves are transferred to the evaporating dish, 75 cc. of acetone are placed in the washing dish (containing drippings from the leaves). Another 75 cc. is placed in a similar dish which is used for rinsing. The leaves are taken one by one from the evaporating dish, washed for one minute in the washing dish, drained, rinsed for 30 seconds, drained, dried and placed in a clean, dry, tared beaker for weighing. All handling of leaves during washing is done with forceps. After weighing, 6 per cent of the total weight is added to each batch of leaves to make up for loss of weight during manipulation.

The total area of each batch of leaves is determined by tracing the leaves on sheets of paper of known area. The leaf tracings are cut out and weighed and the balance of the sheet of paper also weighed. With this data, the area of the batch of leaves is determined.

As soon as the leaves are washed the solution from the washing dish is transferred to the evaporating dish which held the sprayed leaves before washing and which also contains some drippings. The washing dish is rinsed inside (and outside where the solution was poured over the lip) with two 15 cc. portions of acetone which are washed into the evaporating dish with the original solution.

The evaporating dish containing the solution from the washing dish is placed on a hotplate and the acetone and water evaporated. The hotplate is made up of a resistance coil, consuming 500 watts at 110 volts plugged into a circular porcelain casing $5\frac{1}{2}$ inches in diameter and $1\frac{1}{2}$ inches thick. The circular porcelain casing is covered with a square iron plate 12 by 12 inches by one-quarter inch, the plate being insulated underneath with a sheet of eighth-inch asbestos. Four half-inch square nuts, one-half inch thick, on top of the iron plate, support a thin, perforated copper plate such as are used as shelves in electric ovens. This device places the evaporating dishes at the right distance above the source of heat to have the acetone and water evaporate at 50° C at a rate of 70 cc. per hour.

When the major part of the solution in the evaporating dish has evaporated, the remaining portion becomes quite turbid due to the mixture of oil globules and water which has not been completely evaporated. Evaporation is continued until the oil globules start to come to the surface. At this stage 15 or 20 cc. of the rinse solution is added and evaporation continued until the solution again becomes turbid. Another portion of the rinse solution is added and this procedure continued until all the rinse solution and water have been evaporated. By the time all the acetone is evaporated all the water will also be practically evaporated, and the oil will rise to the surface when but 1 or 2 cc. of liquid remain

in the evaporating dish. From this point evaporation is continued until all water and practically all the solvent is gone and smoke begins to rise from the dish. This point is designated as "zero time" of overheating of mineral oil.

As soon as the smoke appears the dish is taken from the hotplate and cooled to room temperature. When the dish has cooled the soluble residue is dissolved in 10 cc. of petroleum ether (boiling point 20–40° C) and the ether solution filtered into a 50-milliliter beaker. The solution is filtered into the beaker through a filter paper which has first been used to wipe off the edge of the evaporating dish in order to remove any oil which may have crept to the edge of the dish during evaporation of the acetone. The evaporating dish is rinsed twice with 5 cc. portions of the

Table 1.—Effect of sulfonation on oil.

Grams Oil Introduced	Grams Oil Recovered	Grams Oil Introduced	Grams Oil Recovered
.052	.049	.135	.132
.060	.058	.210	.208
.082	.078	.275	.280
.098	.102		

ether and the rinses added to the solution in the beaker. Care must be taken to rinse thoroughly the evaporating dish and the outside edge of the pouring lip. The ether solution from the 50 cc. beaker is transferred to a Babcock bottle of about 50 cc. capacity. The bottle is 16.5 cm. high, the neck 10 cm. long with a 7 cm. graduated portion. The inside diameter of the neck is .6 centimeter. The graduated portion holds 2 cc. and is graduated into 50 divisions, each division representing .04 cc.

The ether is evaporated from the bottle on a steam bath and the final two or three cc. are driven off by placing the bottle in an electric oven at 105° C for 45 minutes. After heating, the bottle is cooled and the oil sulfonated by adding 20 cc. of 98.61 per cent sulfuric acid and heating the bottle in a steam bath for one hour; the bottle being removed from the bath every 10 minutes and shaken for 10 seconds. The amount of oil is determined from the reading in the neck of the sulfonation bottle after centrifuging.[2]

Validity of the method.—Certain points which might be brought up as questioning the validity of this method have been considered and worked out during the development of the procedure.

1.—*Does acetone wash all adsorbed oil from the surfaces of leaves?* In the experiment devised to check this point, 24 orange leaves having a total area of 135 square inches on one side (270 square inches on both sides), were smeared with .3725 grams of oil. The leaves were then treated with water and run through the washing process and the

[2] *Oil:* The oil used in this work had the following specifications.

Gravity	29.3° API
Viscosity, Saybolt	87 seonds at 100° F
Unsulfonated residue	92 per cent (Calif. State Dept. Ag. Method)
Distillation	6 per cent at 575° F
	37 per cent at 636° F
	70 per cent at 709° F

acetone solution—through the procedure previously described. After sulfonation .361 grams of oil (97 per cent) were recovered in the Babcock bottle.

2.—*Effects of sulfonation on the oil.* In order to determine the effects of sulfonation on the oil being tested by this method, it was found neces-

Table 2.—Effect of essential oils etc., on sulfonation.

Bottle No.	Drops Oil Introduced	Grams Oil Introduced	Grams Oil Recovered
0	0	.0	.0
1	4	.0505	.055
2	8	.107	.108
3	12	.164	.161
4	16	.214	.208
5	20	.272	.268

sary to make sulfonation tests on known amounts of each stock oil used. Oil varying in amount from 4 to 20 drops was placed in the sulfonation bottles and readings made in each case after sulfonation. From these readings, a master curve was drawn for each stock oil from which determinations of the amounts of oil recovered in the various experiments were made. Table 1 shows the amounts of oil introduced and recovered in the original test.

3.—*Effect on oil determination of foreign matter, plant waxes and essential oils which may be dissolved or washed from the leaves by acetone.* In this experiment 170 leaves were washed in 1000 cc. of acetone and the resulting solution divided into five equal portions. Each portion was evaporated separately and the residues transferred to Babcock bottles. To one bottle was added 4 drops of oil, to the next 8 and so on through 12, 16 and 20 drops per bottle. Each bottle was put through

Table 3.—Loss of oil during evaporation of acetone.

Grams Oil Introduced	Minutes Heated after Appearance of Smoke	Grams Residue after Evaporation	Grams Oil Recovered
.242	0	.347	.244
.256	5	.367	.254
.255	10	.291	.254
.249	15	.278	.226
.241	30	.241	.220
.246	45	.246	.220

Table 4.—Loss of oil during heating in electric oven.

Minutes Heated	Grams Oil Introduced	Grams Oil Recovered
45	.277	.280
60	.277	.280
90	.279	.280
150	.273	.268

the sulfonation test and the amount of oil recovered was determined in the usual manner. Table 2 shows the amount of oil introduced and recovered in each case.

4.—*Loss of oil during evaporation of acetone.* To determine the oil loss during this part of the procedure, four of the evaporating dishes were tared and 15 drops of oil were weighed into each dish. The regular amount of acetone (200 cc.) was evaporated from each dish and the dishes were removed from the evaporating plate at different times vary-

ing from 0 to 45 minutes after the appearance of smoke in the dish. The dishes were cooled and weighed, after which the residues were transferred to Babcock bottles and the oil determined by sulfonation. The results of this experiment are given in table 3. It is evident from the above data that overheating, even as long as 10 minutes, does not affect the result materially.

5.—*Loss of oil from Babcock bottles during heating in electric oven.* Definite amounts of oil were weighed into Babcock bottles; 40 cc. of petroleum ether were added to each bottle. Most of the ether was evaporated by placing the bottles on a steam bath. The bottles were placed in the electric oven for evaporation of the last of the ether and left there for varying periods. The oil was recovered and determined in the usual manner. Results of this experiment are shown in table 4.

Conclusions.—A method for determining the amount of oil deposited on orange leaves has been presented. This method is of particular advantage due to its being rapid, as determinations of oil can be started before the spray has dried. In fact, it is essential in this method that the leaves be washed free of spray immediately after spraying.

It has been proven experimentally that acetone U.S.P. is an efficient solvent for use in this method.

It has been demonstrated that providing careful technic is maintained no amount of oil of significant importance is lost during any of the various parts of the procedure.

A sulfonation curve for determining the amount of oil in sulfonation bottles must be constructed for each oil to be determined by this method.

Although the development of this method and the experimental work to date have been confined to orange leaves, the authors can see no reason for its not being used with other varieties of leaves.

Acknowledgments.—The authors wish to acknowledge the assistance of Dr. W. M. Hoskins of the Division of Entomology and Parasitology of the University of California in reading and criticizing the manuscript, and the helpful suggestions and cooperation of R. K. Vickery of the California Spray-Chemical Corporation.—3-4-37.

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White-pine blister rust control areas having recently been legally established in Maryland, Ohio, Pennsylvania and Wisconsin, wherein the planting and possession of currant and gooseberry plants is forbidden under state authority, the U. S. Department of Agriculture, effective March 1, 1937, revised the quarantine regulations relating to the disease to provide that interstate shipments of such plants to these states must be accompanied by a control-area permit obtained from the officer of the state of destination. Such permit provisions now apply to 13 states. Some minor modifications relating to pine shipments were also made in the regulations.

Toxicity of Phenothiazine Derivatives to Culicine Mosquito Larvae

P. S. Schaffer, H. L. Haller, and D. E. Fink, *U. S. Department of Agriculture, Bureau of Entomology and Plant Quarantine*

Discovery of the high toxicity of phenothiazine (thiodiphenylamine), fig. 1, to culicine mosquito larvae by Bulger (Campbell, *et al.*, 1934, addendum) and to the codling moth by Smith, Munger & Siegler (1935) made it desirable to prepare derivatives of this substance to determine whether the toxicity of a molecule known to possess insecticidal action can be increased by the introduction of various atoms and radicals.

Several different types of derivatives of phenothiazine are possible. The hydrogen atom on the nitrogen atom can be replaced by various radicals or groups, *e.g.*, CH_3, $COCH_3$, COCl, the hydrogen atoms in one or both benzene rings can be replaced by other atoms or radicals, and both the hydrogen on the nitrogen atom and in the benzene ring can be substituted.

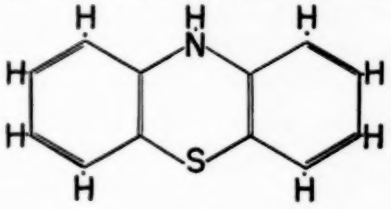

Fig. 1.—Structural formula of phenothiazine.

A number of derivatives in which the hydrogen atom on the nitrogen atom has been replaced by other groups are described in the literature and are readily accessible. Eight derivatives of this type were prepared and tested against mosquito larvae. The results are given in table 1.

Attempts were also made to replace the hydrogen on the nitrogen atom by the phenyl group and the alpha-pyridyl group, but without success. The preparation of the N-phenyl derivative was also tried by preparing triphenylamine and allowing it to react with sulfur. In contrast to the ready manner with which diphenylamine reacts with sulfur, triphenylamine did not react at all.

Derivatives in which one or more of the hydrogen atoms in the benzene ring have been replaced are also described in the literature, but this type of derivative is more difficult to prepare than the nitrogen-substituted derivative. These compounds would be of considerable interest for studies on the relationship between chemical constitution and insecticidal action, because a number of isomeric compounds are possible.

Three phenothiazine derivatives substituted in the benzene nucleus were tested. Methylene blue and thionin were commercial preparations purchased in the open market. Dithiocyanophenothiazine was prepared from phenothiazine by the procedure developed by Kaufmann & Liepe (1923) for the introduction of the thiocyano group. The results obtained with these materials are also given in table 1.

It should be possible to prepare phenothiazine substituted in the benzene nucleus from a substituted diphenylamine and sulfur. The substituted diphenylamines can be conveniently prepared by decarboxylation of the corresponding carboxylic acids. The latter are obtained from

o-chlorobenzoic acid and a substituted aniline by the procedure described by Ullmann (1907). When 2-methyl, 3-methyl, 4-methyl, 2-chloro, 3-chloro, 4-chloro, 2-nitro and 4-ethoxy diphenylamine were allowed to react separately with sulfur under the conditions employed for diphenylamine, hydrogen sulfide was given off in most cases, but in no instance was it possible to obtain a crystalline product. Several experiments were carried out in which the substituted diphenylamine carboxylic acid was allowed to react with sulfur, but here also the results were negative.

Table 1.—Toxicity of phenothiazine and its derivatives to culicine mosquito larvae.

Compound	Concentration P.p.m.	Application*	Mortality after 16 Hours Per cent	Solid Particles Visible in Water
Phenothiazine	1	A	100	No
6-Methylphenothiazine	2	A	48.5	No
6-Ethylphenothiazine	5	A	53	No
Phenothiazine-6-carboxylic acid amylamide	10	I	94	Yes
Phenothiazine-6-carboxylic acid amide	50	A	55	No
6-Acetylphenothiazine	100	I	94	Yes
Phenothiazine-6-carboxylic acid *o*-chlorophenylamide	100	I	60	Yes
Phenothiazine-6-carboxylic acid chloride	100	I	0	Yes
Phenothiazine-6-carboxylic acid phenylamide	100	I	0	Yes
Dithiocyanophenothiazine	100	I	0	Yes
Methylene blue	100	W	0	No
Thionin	100	W	0	No

* *A* indicates that an acetone solution of the compound was added to water, *I* that the compound was added to water in solid form because it was only slightly soluble in acetone and water, and *W* that the compound was tested in aqueous solution without acetone.

All the compounds were tested against mosquito larvae, *Culex quinquefasciatus* Say, beginning the fourth instar. The method used was essentially the one described by Campbell and co-workers (1934). Fifty larvae were used in each experiment, and preliminary tests were conducted at concentrations of 1, 2, 5, 10, 20, 40, and 100 parts per million parts of water. Later the compounds were retested in duplicate at their effective range of toxicity, and phenothiazine at the concentration of 1 part per million was used as a standard for comparison. Temperatures were maintained at 26° C throughout the tests by means of a water bath.

In table 1 the derivatives of phenothiazine have been arranged in order of effectiveness as compared with phenothiazine. It will be observed that all derivatives are markedly less toxic than phenothiazine, and in almost half of the compounds toxicity was not attained at the concentration of 100 parts per million. 6-Methylphenothiazine was one-half as toxic as phenothiazine and 6–ethylphenothiazine one-fifth as toxic as the parent compound.

Summary.—Eleven derivatives of phenothiazine were tested against culicine mosquito larvae to determine the effect of substituents in a molecule known to possess high toxicity. 6–Methylphenothiazine was one-half as toxic as phenothiazine, and all the other derivatives were even less toxic.—3-17-37.

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Weight of Adult Housefly[1]

And Effect of a Sublethal Dose of Sodium Arsenite upon It[2]

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This investigation had two major objectives: first, to determine the normal distribution of the weights of male and female houseflies; and second, to determine the effect of a sublethal dose of sodium arsenite on the body weight. It was the opinion that this investigation would con-

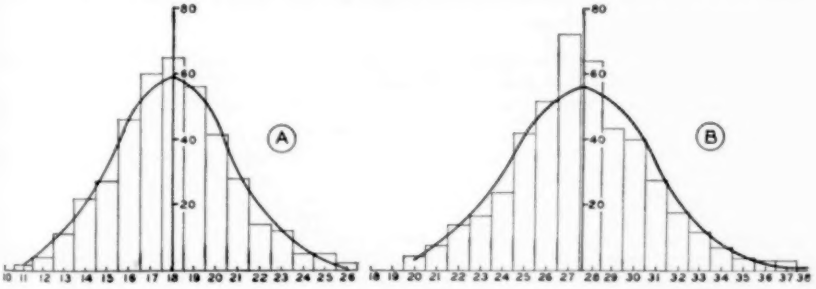

Fig. 1.—Normal curve for the weights of houseflies. *A*, male, *B*, female.

tribute information concerning the normal distribution of the weights of flies reared on a standard diet which would be useful for comparisons in subsequent toxicity and other studies.

Materials and methods.—The flies used for these studies were reared in the laboratory in a food mixture similar to the one described by H. H. Richardson (1932). Random samples from a large population of adult

[1] *Musca domestica* L.

[2] Journal paper J410 of the Entomology and Economic Zoology section of the Iowa Agricultural Experiment Station, Ames; project 137.

[3] On leave from Texas Agricultural Experiment Station during school session 1935–36.

flies which had been fed a milk diet for three days were used to obtain the weights. Each fly was weighed in a gelatin capsule, released, and the capsule weighed immediately, in order to eliminate as much error as possible. The weights were recorded to the nearest one-half milligram.

The sodium arsenite solutions for the feeding tests were prepared

Table 1.—Ratios of one measure of dispersion of weights of adult houseflies to another in studies conducted at Ames, Iowa, 1936.

	Ideal Symmetrical Distribution	Weights of 457 Female Houseflies	Difference	Weights of 402 Male Houseflies	Difference
Standard deviation (S)	1.2533×A.D.	1.3028×A.D.	.0495	1.3426×A.D.	.0893
Standard deviation (S)	1.4825×Q	1.4982×Q	.0157	1.5491×Q	.0666
Average deviation (A.D.)	.7979×S	.7676×S	.0303	.7447×S	.0532
Average deviation (A.D.)	1.1843×Q	1.1500×Q	.0343	1.1537×Q	.0306
Semi-interquartile range (Q)	.6745×S	.6675×S	.0070	.6455×S	.0290
Semi-interquartile range (Q)	.8453×A.D.	.8696×A.D.	.0243	.8662×A.D.	.0209

from arsenic trioxide C.P. and a standard solution of sodium hydroxide. These solutions were administered to unfed flies, four to six hours after emergence.

Two samples of flies were taken from the same population; one was allowed to feed 18 hours *ad libitum* on a sodium arsenite solution of known As_2O_3 concentration, containing 15 grams of sucrose per 100 cc. of solution, the other received only a sugar solution during this period. The two lots of flies were then fed fresh milk twice daily for about six days. At the end of this period the flies were weighed individually to the nearest one-half milligram as previously described.

Results of weighing tests.—The weights of the flies were grouped and are shown in the histograms, fig. 1. The measures of dispersion, and the ratios of one measure to another were calculated and are shown in tables 1 and 2.

Table 2.—Measures of dispersion of the weights of male and female adult houseflies in studies conducted at Ames, Iowa, 1936.

	Female	Male
Mean, milligrams	27.650	18.075
Average deviation	2.530	1.997
Semi-interquartile range	2.200	1.730
Standard deviation	3.296	2.680
Third moment μ_3	15.224	1.160
Fourth moment μ_4	445.240	163.520
α_3	.425	.060
α_4	3.770	3.170
Skewness	.212	.030
Kurtosis	.390	.090

It will be noted that the differences were small between the ratios of one measure to another of an ideal symmetrical distribution, and the ratios found in the distribution of the weights of male and female flies. This indicates a close approach of the distribution of weights to the normal form. The third and fourth moments about the means were calculated, from which measures of skewness and kurtosis are both zero in a normal distribution, but it is observed that the distribution of fe-

male weights has skewness as well as kurtosis. However, the skewness is small (.212) denoting that the curve bulges slightly more to the right of the mean than to the left. This distribution also has a slight kurtosis (.390) signifying that the weights are spread outward on one side to a greater distance than the extent of the standard deviation. The values for skewness and kurtosis of the distribution of male weights are very small indicating a very close approach to the normal. Since the distributions of both male and female weights were nearly symmetrical, they were fitted approximately by curves whose equations are:

Female $$y=\frac{457}{3.296\sqrt{2\pi}}\ C-\frac{(t-27.65)^2}{2(3.296)^2}$$

Male $$y=\frac{402}{2.68\sqrt{2\pi}}\ C-\frac{(t-18.075)^2}{2(2.68)^2}$$

To plot these curves as shown in figs. 1 and 2, we have set,

$$x = \frac{t - \bar{t}}{S}$$

and have used the equations in the form,

$$y = \frac{n}{S}\phi(x)$$

The values for $\phi(x)$ were obtained from tables by Camp (1931). As previously discussed, a slight skewness and kurtosis was found in the distributions. The chi-square test was applied to the observed and expected frequencies of these distributions. In applying the test the groups were pooled when the expected value was less than 5. Using 15 classes in the female distribution, the chi-square value = 17.37, with 13 degrees of freedom, P. between .1 and .2. With 13 classes in the male distribution, chi square = 16.38, with 11 degrees of freedom, P. between .1 and .2. In both cases the test shows that the observed frequencies are in close agreement with the expectation. The mean, area, and standard deviation of the theoretical curves are equal to the mean, area, and standard deviation, of the respective histograms, or observed frequencies.

Results with sodium arsenite solutions.—The results of these tests are shown in table 3. The t values were calculated to test the significance of the difference between the mean weights of flies from the check and the poisoned lots. In all cases the t values were nonsignificant. Since the concentration of .03 gram of As_2O_3 per 100 cc. solution killed 70 per cent of the flies in the sample of 180, while only 14 per cent died in the check, it is believed that the flies which were weighed from the samples that received .01 and .02 gram of As_2O_3 per 100 cc. sugar solution, ingested generally sublethal quantities of the poison. The weights of the experimental flies did not differ significantly from those of the check flies when the concentration of .03 gram As_2O_3 was used, which concentration killed more than half the flies. The flies in all the poisoned samples were

more sluggish than those in the checks six days after feeding, which indicated that they were affected by the poison, but not in such a manner as to affect the weight.

Summary and conclusions.—The mean weight of 402 male houseflies, *Musca domestica* L., was 18.075 milligrams, and of 457 females 27.650 milligrams. The distributions of these weights closely approached the

Table 3.—Toxicity of sodium arsenite to adult houseflies in studies conducted at Ames, Iowa, 1936.

Concentrations As_2O_3,* Grams per 100 cc.	No. Flies Weighed		Mgs. Mean Weight		Per Cent Dead†
	Male	Female	Male	Female	
		Poisoned Flies			
.01	12	30	17.04	27.72	
.01	35	23	16.64	26.54	29
.02	26	24	19.78	28.18	48
.02	16	11	17.35	25.46	64
.03		30		27.56	70
		Check Flies			
	14	25	15.53	28.37	
	34	21	15.76	26.29	18
	17	17	18.42	27.75	21
	25	15	16.46	25.37	40
	20	16	17.14	27.29	14

t value‡	
Male	Female
.732	.137
.981	.115
.975	.195
.664	.030
	.135

* The solution contained 15 grams of cane sugar per 100 cc. water.
† Per cent of the total sample dead in the cage one week after emergence.
‡ Fisher, 1934.

normal. The weights of the females were more variable than those of the males, probably reflecting the somewhat unequal development of the eggs in the individuals of the female population. Flies which were allowed to feed *ad libitum* for 18 hours upon sublethal concentrations of sodium arsenite in sucrose solution and then were fed milk for about six days did not differ significantly in weight from normally fed flies. The poisoned flies were distinctly more sluggish six days after feeding upon the arsenical solution than the control flies.—3-11-37.

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Convenient Method of Rearing the Stable Fly

A. E. Doty, *Röhm and Haas Co., Inc.*,[1] *Bristol, Pa.*

During the summer of 1936 large numbers of the stable fly, *Stomoxys calcitrans* L., were desired for insecticidal investigations on cattle sprays. This necessitated an effective and practical laboratory method of rearing this fly.

Various workers in this field have devised methods of breeding *Stomoxys*, both in the laboratory and out of doors. Melvin (1932) raised large numbers of *Stomoxys* flies in a modified hotbed containing a mixture of oat straw and horse manure for use in cattle spray experiments.

Herms (1923) successfully reared fairly large numbers of *Stomoxys* in the laboratory but does not state in what manner.

Glaser (1923) conducted extensive feeding experiments on flies and later (1924) gives in detail excellent methods of rearing the house fly, *Musca domestica* L., the stable fly, *Stomoxys calcitrans*, and the horn fly, *Haematobia serrata* R. Desv. These flies were reared in glass battery jars, using fresh horse manure for a medium. Feeding the adult *Stomoxys* on live animals proved impractical, so defibrinated, whole horse or cow's blood was fed by dropping it onto the covers of the rearing jars. Reared in this manner, the preoviposition period of the adult *Stomoxys* varied from nine to 13 days with a mean of 10 days, while the longevity varied from three to 46 days with a mean of 20 days. Glaser further states that five generations of *Stomoxys* were raised in this manner.

Since we were familiar with the rearing of house flies by the Grady method (1928), which is based on Glaser's work, we proceeded to adapt this method to the stable fly.

Adult and larval food.—The use of cow's blood, as pointed out by Glaser (1924), proved to be by far the easiest and most effective way of providing nourishment for the adult *Stomoxys*. Instead of defibrinating this blood, sodium citrate was added to prevent coagulation. This proved very effective and appeared to have no harmful effects on the flies or progeny. The blood was caught from freshly slaughtered calves in sterilized quart jars containing 90 cc. of a sterilized 2 per cent sodium citrate solution. The jars were filled only about seven-eighths full to allow for the immediate vigorous shaking necessary if the blood was to be kept for any time. This citrated blood was then placed in a refrigerator as soon as possible. Prepared in this manner, blood could be kept for as long as two weeks.

The artificial medium used for both the egg deposition and larval development was originally developed by H. H. Richardson (1932). It was prepared by mixing $8\frac{3}{4}$ pounds of wheat bran and $6\frac{1}{2}$ pounds of alfalfa meal together in a large container. In another container 14 quarts of water, 2 fluid ounces of *Diamalt* and $1\frac{1}{2}$ pints of yeast suspension were thoroughly mixed and this solution was then incorporated into the bran–alfalfa mixture until uniform. The yeast suspension was made by thor-

[1] Early publication of this paper has been secured by payment of the printing charge.

oughly suspending one-half pound of baker's yeast in 1 quart of water. (The baker's yeast and *Diamalt* may be obtained from the Fleischman Yeast Company.) It was found that this medium, satisfactory for rearing house flies, tended to pack too much for *Stomoxys* larvae. A small quantity of oat hulls (about 1 pound) added to this medium prevented packing.

Methods and equipment.—As finally worked out, our method of rearing *Stomoxys* and the equipment used were as follows:

The insectary consisted of a small brick building 11 feet square and 10 feet high. Windows in three sides provided ample light. Shelves were built along the west side for the breeding cages. Heat was supplied by a large steam radiator under the north window, regulated by a standard steam thermostat in the line. This maintained the temperature fairly well from 70 to 80° F. The humidity was increased, when necessary, by evaporation from large pieces of cheesecloth partly immersed in water.

The type and size cage found most suitable for both breeding and stocking the flies was 18 inches long, 12 inches high and 11 inches wide, the top, sides and back being covered with one sixteenth-inch mesh copper screen. The frame and bottom were constructed of wood, the front framework being grooved to receive a glass slide which served as the door. The pupal cages were similar to the breeding cages but much smaller.

Standard glass battery jars, approximately 5 inches in diameter by 8 inches high, proved best for rearing the larvae.

From 50 to 200 wild or hatched flies were kept in each breeding cage. In each of these breeding cages an egg deposition tray and a petri dish of blood were kept just inside the glass slide, the petri dish resting on the medium in the tray. Ordinary tin can tops 7 inches in diameter by three-eighths of an inch deep proved excellent for deposition trays, many of the eggs being deposited around the edge of this tray and under the petri dish. The breeding cages were divided into two groups, and the medium containing the eggs removed from the cages in each group on alternate days. Thus each depositing tray contained eggs from two days of laying, and this proved about the right number of eggs for the rearing jars used. Each jar was filled about three-quarters full of freshly mixed medium, and the deposition medium containing the eggs was emptied over this, one tray to a jar. The medium was then well mixed with a spatula, cheesecloth was placed over the jar, which was then dated, marked and placed on a shelf.

The developments in the rearing jars were noted from time to time by careful probing in the medium with a spatula. If the medium appeared too dry, more water was sprinkled over it, care being exercised not to get the medium too soggy. If too many larvae were present, more medium was introduced from time to time to prevent the larvae from exhausting the food supply. If the food supply became exhausted or the moisture content was too low, the larvae developed very slowly and produced small, inferior flies. In some instances of this sort only part of the larvae would develop at a given time, several hatches of flies coming off over a period of several weeks, although all the eggs were laid at nearly the same time.

The transferring of the adults was accomplished by simply placing the receiving cages in the light in such a position that the flies liberated from the rearing jars would be attracted to the rear of the cage.

The flies were fed early in the morning and late in the afternoon with the citrated blood, which was transferred from the stock jars to a small bottle placed in warm water to raise the temperature of the blood to 30–35° C. This warm blood was poured into the petri dishes until it covered the bottom, and a square of absorbent cheesecloth was placed in the blood to prevent the flies from drowning. Most of the flies engorged at once after the blood was introduced; a few, however, fed later in the day on the second introduction of blood.

In order to lessen the possible transfer of mites sometimes introduced on wild flies and also certain injurious bacteria, the rearing jars were steamed after each batch and the cages used received a similar treatment from time to time. In spite of this precaution, however, mites at times became quite troublesome. To keep the hatched flies free from them, the medium containing the pupae was washed into a pail of water. The pupae then floated to the surface and were skimmed off with strainers and placed in the pupal cages. The washing apparently had no harmful effects on the pupae.

Development of the *Stomoxys* reared by the method as outlined was as follows: egg, two to five days; larva, nine to 15 days; pupae, four to 14 days. Reared flies laid fertile eggs in seven to 14 days. The adult flies lived two to 30 days with a mean of about 13 days.

Insecticidal tests were conducted on both wild and reared *Stomoxys* flies by the Peet-Grady method, using aliphatic thiocyanate (*Lethane 384*), pyrethrum and rotenone sprays. In these tests the *Stomoxys* were found to be considerably less resistant than house flies.

Field and laboratory repellency tests showed that *Stomoxys* are repelled by these same sprays in about the same degree as are house flies. Therefore data obtained from repellency tests conducted on house flies with any of the materials given above are also applicable to the *Stomoxys*.

Summary.—A method is described for rearing large numbers of the stable fly, *Stomoxys calcitrans* L. The stable fly has a very low resistance to sprays containing pyrethrum, rotenone or thiocyanates. The stable fly is not as suitable for laboratory repellency tests as the house fly.—3-19-37.

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Importation and Laboratory Breeding of Two Chalcid Parasites of *Pseudococcus brevipes* (Ckll.)

WALTER CARTER, *University of Hawaii, Experiment Station of the Pineapple Producers Cooperative Association, Ltd., Honolulu.*[1]

Importations of parasites of the pineapple mealybug, *Pseudococcus brevipes* (Ckll.), to Hawaii have been conducted over a period of years. Although many species have been successfully shipped, no successful rearing on local *P. brevipes* has been accomplished prior to the results of this study, which concerns two species of chalcid parasites, *Hambletonia pseudococcina* Compere (Compere, 1936) and *Anagyrus coccidivorus* Dozier (Dozier, 1932).

Importation.—Importations are recorded in table 1.

Table 1.—Importations of two chalcid parasites of pineapple mealybug into Hawaii.

DATE	PLACE	COLLECTOR	NO. MALES	NO. FEMALES
		Hambletonia pseudococcina Compere		
Oct. 1935	São Paulo, Brazil	E. J. Hambleton*	29	29
Nov. 1935	São Paulo, Brazil	E. J. Hambleton	5	3
Nov. 1935	Barbosa, Colombia	Enrique G. Salas†	0	2
Dec. 1935	Rio de Janeiro, Brazil	D. T. Fullaway‡	0	6
Feb. 1936	Barbosa, Colombia	Enrique G. Salas	0	8
June 1936	Venezuela	Enrique G. Salas	0	79
July 1936	Venezuela	Enrique G. Salas	0	199
Aug. 1936	Venezuela	Enrique G. Salas	0	26
		Anagyrus coccidivorus Dozier		
Dec. 1935	Rio de Janeiro, Brazil	D. T. Fullaway	9	17
Jan. 1936	Rio de Janeiro, Brazil	D. T. Fullaway	6	4
Mar. 1936	Rio de Janeiro, Brazil	D. T. Fullaway	6	8

* Entomologist, Instituto Biologico de Defesa Agricola e Animal, São Paulo, Brazil, South America.
† Pineapple Experiment Station collector.
‡ Bureau of Entomology (AAA Project).

Breeding experiments.—Handling of *P. brevipes* under laboratory conditions presents difficulties, for without ant attendance *P. brevipes* colonies grow weak rapidly, due to accumulation of honeydew and exuviae. The technic first used was to release the parasites on a large caged pineapple plant on which large numbers of mealybugs had been placed. The first shipment of *H. pseudococcina*, comprising 29 pairs, was so treated but no reproduction occurred. *A. coccidivorus* reproduced, but with little increase. The large cage proved unwieldy because it was difficult to check the progress of the mealybug colony and to remove the adult parasites after they emerged.

The second method was to cut off the lower, thick ends of pineapple

[1] Published with the approval of the Director as technical paper 96 of the Pineapple Experiment Station, University of Hawaii, Honolulu.

leaves and infest them heavily with mealybugs. After colonies had become established, the well-infested leaves were removed to a large glass jar and the parasites introduced. Neither of the last two shipments of *H. pseudococcina* from Brazil, together comprising five males and nine females, reproduced under these conditions. From the two females sent by Enrique G. Salas from Colombia three females emerged, and from these, two additional generations were bred but with practically no increase and without the emergence of males. The process was then repeated with new material sent by Mr. Salas. The results showed that the Colombia strain of the species would breed freely on *P. brevipes* in Hawaii.

The failure of *H. pseudococcina* from Brazil to breed on *P. brevipes* in Hawaii and the consistent reproduction of the same species from Colombia and Venezuela is difficult to account for except on the hypothesis that a difference occurs in biological strains. The relative sex ratios of the two strains indicate that the strain from Brazil is normally bisexual while that from Colombia and Venezuela is parthenogenetic.

A. coccidivorus bred more freely with the second method of rearing than with the previous technic. The first shipment of nine males and 17 females produced only males; the second shipment failed and the third produced 26 males and 22 females.

A third propagation method was then developed which was satisfactory for both species. This consisted of infesting young pineapple fruits and enclosing the infested fruit in a celluloid cage, fig. 1. After the host colony had developed, parasites were introduced through the side sleeve. The method differs from those

Fig. 1.—Breeding cage for parasites of *Pseudococcus brevipes* (Ckll.). Mealybug colonies are first established on the enclosed growing fruit and the chalcid parasites then introduced through the side sleeve.

previously used in that the mealybugs are colonized on developing fruits. With this method a mealybug colony develops normally for a period long enough to permit the complete emergence of a single generation of the parasite. At the same time the parasites have opportunity to select the stages most suitable for parasitism.

Although only one generation of parasites can be raised on one fruit (since after approximately a month has elapsed the mealybug colony becomes weakened through lack of attendance), this method has resulted in a satisfactory increase, up to 50-fold, of both species of parasites. Regular releases to pineapple fields are being made. The life cycle of the two species differ, *A. coccidivorus* emerging after approximately 20 days and *H. pseudococcina* after 30 days. *A. coccidivorus* produces an approximately equal number of males and females, but from 707 specimens of *H. pseudococcina* only two were males.

Summary.—A bisexual strain of *Hambletonia pseudococcina* Compere from Brazil failed to reproduce on *Pseudococcus brevipes* but a parthenogenetic strain of *H. pseudococcina* from Colombia and Venezuela, as well as *Anagyrus coccidivorus* Dozier, reproduced on colonies of *P. brevipes* in Hawaii.

Satisfactory reproduction occurred on mealybug colonies established on young growing fruits enclosed in celluloid cages.—11-30-36.

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Scientific Notes

***Thylodrias contractus* Mots. in Texas.**—Larvae of this dermestid beetle (determined by Dr. A. G. Boving) were reported injuring the stock of silk wearing apparel in a fashionable store in San Antonio during December 1936. Numerous complaints by customers that silk garments purchased contained tiny holes resulted in an investigation which disclosed an infestation of sufficient proportion to require prompt control measures. The species is of European origin and was first reported in this country from New York in 1902. It has since also been recorded from New Jersey and Illinois. Hitherto, the occurrence of the insect in dwellings has been described as annoying but of no economic importance. The larva is small and characterized by transverse rows of flat scalelike bristles on the abdomen above; when disturbed it rolls itself into a ball not unlike the common so-called pillbug. Felt states that, according to L. H. Jontel, one year may be required to complete the life cycle, and that the larva may live three or four years without food.

H. J. Reinhard, *Agricultural Experiment Station, College Station, Texas.*—1-2-37.

Methods in Study and Preservation of Leafhopper Genitalia.—Proper understanding of certain problems in economic entomology is frequently dependent upon a proper identification of the species of insect concerned. This has been demonstrated increasingly in the past few years, especially among the leafhoppers (Cicadellidae). Problems like the potato leafhopper, *Empoasca*, in eastern and western United States, and the apple leafhoppers *Erythroneura* and *Typhlocyba*, in the fruit-growing sections of the country, have demonstrated the importance of correct identity. In many groups of insects the chitinous pieces of the genital chamber (frequently called internal genitalia) are the most important structures used in the separation of species. Frequent requests have been received by the

authors concerning methods of preparation, study and preservation of these structures in the case of the leafhopper group. The following suggestions are given in order to assist those who desire to make detailed studies of a particular group, or those who find it necessary to examine these structures in order to check the identity of species in this or other groups of insects.

The internal genital characters of the male sex are more generally used in making determinations. In preparing specimens for study the entire or posterior half of the abdomen is removed by placing the insect ventral side up in a small groove of the proper size in the edge of a piece of cork. A "minuten nadeln" pin mounted in the end of a large match is then used to separate the abdomen from the thorax. Insects mounted on crimped points are more easily broken during this process than those mounted on straight points. Care should be exercised so as not to lose the abdomen when it comes loose from the thorax, especially if a type specimen is to be examined. After the abdomen is removed it is placed in a glass hydrogen-ion cup, fig. 1, A, 10–12 mm. in diameter and 5 mm. high, to which has been added a few drops of cold 20 per cent potassium hydroxide. The specimens are allowed to soak in this material for several hours, depending upon the character of the chitin and degree of pigmentation. Upon removal the specimen is washed for a few minutes in distilled water and transferred to a similar cup containing glycerine. In this condition it is ready for study. A high-power binocular microscope is necessary to study the prepared specimen properly. The hydrogen-ion cup is placed on the microscope stage and the specimen oriented in the glycerine by means of dissecting needles constructed as stated above. These pins may be used for dissecting out the genital pieces, if that is necessary for their proper study, but the value of the specimen is undoubtedly greater if the pieces are left intact.

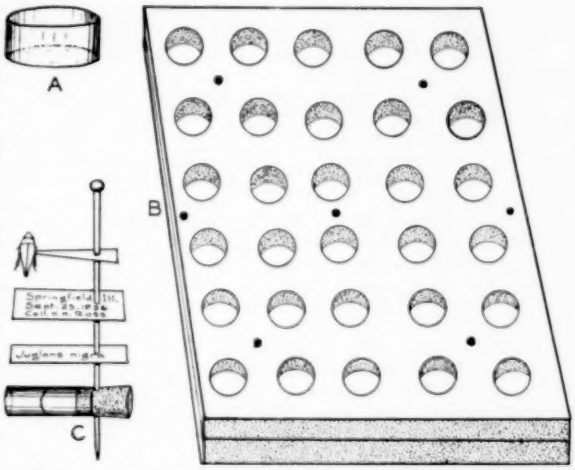

Fig. 1.—*A*, Hydrogen-ion cup; *B*, wooden container for hydrogen-ion cups; *C*, mounted specimen showing minute vial containing genitalia on pin.

To facilitate the transferring of genitalia specimens from one cup to another, a transfer pin may be constructed. It consists of a No. 0 or 1 insect pin which has had the upper third cut off and the blunt end inserted into the end of a large match. The pointed end is then bent into a small loop.

A very satisfactory container for the hydrogen-ion cups may be constructed of two pieces of wood as shown in fig. 1, B. The upper piece has holes of the proper size bored through it and it is nailed to the lower piece. These holes are numbered and correspond to a similar series of numbers placed on small pieces of paper on the pins of the specimens being examined. This prevents any error especially when a large number of specimens are being studied. These containers may be stacked one on another and the top one covered to prevent accumulation of dust in the cups. Such containers also prevent breakage or overturning of the cups.

Drawings of the chitinous pieces are often made with the aid of a slide projection machine, camera lucida, or micrometer eyepiece. To prevent the specimen from moving while being drawn small pieces of fine wire bent in various shapes can be used to hold it in the desired position.

For permanent preservation the genitalia are transferred to minute vials 10 by 4 mm. in which is placed a drop of glycerine. This is placed in the bottom of a vial by means of a medicine dropper specially made with a small outlet at the tip. Be sure to place the tip of

the dropper in the bottom of the vial before squeezing the bulb to force in the glycerine. A cork 3/16 by 5/16 inch with "A-taper" point 3/32 inch is inserted in the open end and the insect pin with the specimen from which the abdomen was removed is placed through the cork, fig. 1, C. With the proper size cork there is little danger of the vial being loosened from it. No method has been used which offers equal advantages of preservation, and ease of observation. The specimens may be quickly removed from the vial at any time, placed in hydrogen-ion cups containing glycerine, oriented in any position desired for study and drawing, and then returned to the original vial. The specimen can be studied much more thoroughly as compared to the fixed position when mounted in balsam or similar mounting materials. On the other hand it may be retained for indefinite periods in the cup or vial without danger of evaporation of the glycerine. Furthermore the viscosity of the glycerine and the capillarity of the vial prevent the glycerine from being spilled or the specimen lost from the vial if it is dropped, overturned, or laid upon its side with the cork removed. Under these conditions the abdomen is more securely preserved and protected than if it were attached to the insect body. Museum pests have been observed to destroy the pinned body while the genitalia in the glycerine containing vial remained undisturbed.

DWIGHT M. DELONG AND RALPH H. DAVIDSON, *Ohio State University, Columbus.*—1-20-37.

Extended Insecticidal Uses of Coal Tar Distillates.—Experiment station workers are increasingly recognizing the value of coal-tar distillate emulsions in the control of aphis and certain other insects on dormant deciduous fruit trees. For controlling the more resistant insects, scale for example, such emulsions are of little value except when used in combination with petroleum oil. When used alone tar acid oils apparently have little or no fungicidal action.

Aside from the toxic properties of these materials and their comparative cheapness, tar distillates have other qualities worthy of note. They are excellent spreading and wetting agents and have commendable adhesive qualities. The feasibility of using tar distillates in conjunction with liquid lime sulfur, arsenate of lead and Bordeaux mixtures in dormant and post-dormant spraying would appear, therefore, to justify investigation.

Since 1933, experiments have been conducted along these lines through the cooperative efforts of a large number of important fruit growers throughout the country. The results of these studies indicate that coal tar distillates are of value in the control of orchard insects, aside from their established use in dormant spraying for aphis. These extended uses may be summarized as follows:

(1) Coal tar distillate emulsions may be satisfactorily used as a cover spray for the control of aphis. Since these materials differ considerably in their chemical constitution, it is necessary to determine, with each brand, what dilution can be used with safety to foliage and yet give desired results. Some growers, who prefer to use fairly strong concentrations of tar acid oil, find it necessary to incorporate dehydrated lime to prevent burning of foliage.

(2) Coal tar emulsions can be used to advantage with lime sulfur for use either in dormant or post-dormant spraying operations. Many growers report excellent results with this combination and find that not only do they achieve better coverage but are able to decrease the amount of lime sulfur normally called for in spraying schedules by one-quarter or more and still get good commercial control.

(3) As a spreader and sticker for arsenate of lead, coal tar distillates warrant consideration. Occasional difficulty has been experienced in obtaining a good stable mixture when these materials are used in combination, but this is readily overcome by adding casein or dry skim milk to the arsenate of lead (in amount equal to the latter) before mixing with the clear water in the spray tank.

Unfortunately, no data are available at present regarding the adhesiveness, when used as described above, of arsenate of lead to fruit if and when washing becomes a necessity. This problem will shortly be investigated.

(4) As a spreader and sticker for copper sulfate and hydrated lime, as ordinarily used in Bordeaux mixtures, coal tar distillates have been reported to give good results. The three substances are thoroughly compatible.

For the most part, those concerned with the control of orchard insect pests and diseases have neglected experimentation with coal tar distillates used either alone or in conjunction with any of the standard orchard sprays. It is hoped that this article will cause enough interest in this important group of insecticidal materials to elicit careful investigation and experimentation by entomologists, horticulturists and plant pathologists.

M. H. DONER, *The J. R. Watkins Co., Winona, Minn.*—1-2-37.

Dry Pyrocide and Gypsum for Control of the Squash Bug, _Anasa tristis_ DeG.—Out of 200 individual cage tests with various concentrations of dusts and liquid sprays, *Dry Pyrocide*, a concentrated stabilized pyrethrum dust, with finely ground gypsum, gave the best control. This insecticide when mixed 1 part with 5 parts gypsum, gave practically 100 per cent kill on the bugs hit with the dust. *Terra Alba* a proprietary brand of gypsum (97 per cent through 325 mesh) gave the best results as a diluent.

Field tests using a bellows duster gave the same result. No burning was noticeable on 15 varieties of squash plants, although when sulfur was used as a diluent instead of gypsum, slight burning occurred on true hubbard in hot weather.

Counts were made at about 72 hours. At 48 hours after dusting some of the bugs were paralyzed and on their back, but still moving their legs and antennae. At 68 hours the bugs were dead or recovered.

The adult squash bugs continued coming into fields from June 13 to the later part of July, at which time new generation adults were appearing. Thus it is necessary to protect the plants from six to eight weeks. As the dust keeps the bugs off the plants about two days, 12 to 18 applications may be necessary. About five pounds of the dust will cover an acre of seedling squash. When the plants cover the ground, about 20 pounds are necessary to dust an acre.

This dust is 100 per cent efficient on the striped cucumber beetle, melon aphid, Colorado potato beetle, bean beetle and false chinch bug, all of which occurred on squash in 1936.

JOHN L. HOERNER, *Colorado State College, Ft. Collins.*—1-8-37.

Some Notes on the Tunneling Habits of _Hylurgopinus rufipes_ Eich.—Soon after a heavy emergence of *Hylurgopinus rufipes* from American elm logs, *Ulmus americana*, adult beetles were seen digging short bark tunnels into the trunks of apparently healthy American elm trees. These tunnels are of the same type as those in which the adults overwinter. Observations were made in Amherst and Westfield, Mass. A close examination of several trees showed the presence of short bark tunnels in trunks and branches even in the upper parts of the trees. The crotches of some small branches, approximately 1 inch and more in diameter, showed the presence of bark tunnels. In these branches, however, there were decidedly fewer tunnels per unit of area than in the trunk near the ground level.

No case of twig feeding was found, even where twigs lay against a part of the trunk in which there were numerous bark tunnels. This habit apparently differs from that of the newly emerged adults of *Scolytus multistriatus*, which are reported to attack small elm twigs and buds. *Hylurgopinus rufipes* attacked small elm twigs only when confined on them in the field or laboratory. Whenever they had a choice between small twigs and stouter elm material, they attacked the latter.

At approximately the same time the bark tunnels were noticed in the trees in Amherst, the adults of *Hylurgopinus rufipes* were observed to be constructing egg galleries in near-by trap logs. A second generation was started there which is wintering in the larval stage.

W. B. BECKER, *Dutch Elm Disease Laboratory, Department of Entomology, Massachusetts Experiment Station, Amherst.*—4-5-37.

First Record of _Bathyplectes tristis_ (Grav.), a Parasite of the Clover Leaf Weevil in the United States.—In 1922 and 1923 T. R. Chamberlin (1924) recorded *Bathyplectes tristis* (Grav.)[1] in southern Europe as an internal parasite of the larvae of the alfalfa weevil, *Hypera postica* Gyll., and the clover leaf weevil, *H. punctata* Fab. The presence of *B. tristis* at Arlington Experiment Farm, Arlington, Va., was first noted late in March 1935, when one minute larva was found in each of two larvae of *H. punctata* incidental to studies of the entomogenous fungus *Entomophthora sphaerosperma*. On April 15 of the same year one larval parasite emerged from each of two full-grown host larvae among a series of 125 collected April 10. In the field *B. tristis* was first observed on May 20 in the cocoon stage harbored in the cocoon of *H. punctata*.

During the period May 20–27, 1935, 95 *Hypera punctata* cocoons were collected at Arlington Experiment Farm, 17 of which contained the cocoons of *Bathyplectes tristis*. The cocoons of *H. punctata* containing the parasite are readily distinguished, being only slightly more than half normal size. The cocoon of the parasite is elliptical, the long axis measuring about 4 mm. and the short axis about 2.5 mm. It is dark brown at the ends with a light brown band approximately 2 mm. wide around its center.

[1] Determination by R. A. Cushman, U. S. Department of Agriculture, Bureau of Entomology and Plant Quarantine.

The parasites under observation, both in the laboratory and in the field, remained as larvae throughout the summer. Evidence of pupation was observed on September 28, when a prepupa was found in a cocoon collected August 9. One dark and one cream colored pupa were found in two cocoons collected October 3, the dark pupa yielding an adult on October 7. On the same date an adult emerged from a cocoon collected May 20. In 200 sweeps of the net in alfalfa on October 9, 15 adults were taken, while on October 19 four adults were taken in 25 sweeps in red clover.

Among a group of larvae of *Hypera punctata* collected December 9, 1935, 60 of which were sectioned serially, two were found to contain a small larval parasite which was undoubtedly *Bathyplectes tristis*. In both instances the parasites were located in the thoracic region of the host, where they had been feeding on the large visceral fat body surrounding the fore-intestine.

How widely this parasite is distributed is not known. Although not abundant, it appears to be well established at Arlington Experiment Farm. The emergence of the adult parasite is well synchronized with the appearance of the early larval instars of the host. There is, however, good evidence that the heavy larval mortality caused by the fungus *Entomophthora sphaerosperma*, to which *Hypera punctata* is subject in this area during mild rainy periods in the winter and early spring, is an important factor in limiting the potential of this parasite.

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F. F. Dicke, *U. S. Department of Agriculture, Bureau of Entomology and Plant Quarantine.* —2-13-37.

***Eumicrosoma benefica* Gahan as an Egg Parasite of the Hairy Chinch Bug.**—Appearance of the hairy chinch bug, *Blissus hirtus* Montd.,[1] at Arlington Experiment Farm, Arlington, Va., was first noted in August 1934, when an infestation was found concentrated on some experimental plots of velvet and creeping bent grass. During the next spring the species increased greatly in abundance and caused severe damage to the same grass plots, particularly those that were infrequently watered and cut. In July 1935, while observations were being made on the egg-laying habits of *B. hirtus*, adults of *Eumicrosoma benefica* Gahan,[2] the chinch bug egg parasite, were noted in substantial numbers. A collection of 71 eggs of *B. hirtus* later in July showed a parasitization of 52 per cent. *Eumicrosoma benefica* has heretofore been reported only as an egg parasite of *Blissus leucopterus* Say, on which it has been found in sufficient numbers in Kansas by McColloch (McColloch & Yuasa, 1915) to bring about an appreciable reduction in chinch bug infestation. In 1914 Flint (Metcalf & Flint, 1928) introduced *E. benefica* into about 30 localities in Illinois, which appears to be the only record of establishment of this parasite east of the Mississippi river. Indications are that the host, *B. hirtus*, became established at Arlington Experiment Farm through shipments of grass samples from infested areas and that the parasite was introduced along with the host.

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F. F. Dicke, *U. S. Department of Agriculture, Bureau of Entomology and Plant Quarantine* —2-13-37.

Effect of Certain Cold-storage Treatments on Larvae of Cherry Fruitfly.—Preliminary studies were undertaken in 1930 to determine whether cold storage treatments and the processing of pitted cherries would bring about complete mortality of cherry fruitfly larvae. The demand for such information was urgent since the California Department of Agriculture Quarantine Division had held a shipment of pitted cherries shipped

[1] Determination by H. G. Barber, U. S. Department of Agriculture, Bureau of Entomology and Plant Quarantine.

[2] Determination by C. F. W. Muesebeck, U. S. Department of Agriculture, Bureau of Entomology and Plant Quarantine.

into California from an Oregon county infested with the cherry fruitfly. These cherries had been treated at a temperature of 15° F for 14 days before being loaded on a steamer and while on the steamer were held in the refrigerator at a temperature of 20 to 25° F. Other shipments valued at $35,000 were soon to be shipped into California.

Several lots, aggregating a total of nearly 23,000 cherries taken from an infested orchard, were processed in gallon cans at the Oregon State College cannery. These cherries were divided into 19 lots of which nine were treated with sugar and 10 without sugar. The ratio of sugar to cherries was 3 pounds of cherries to 1 pound of sugar. One lot of unsugared cherries was treated at a temperature of 28° F for four hours and then raised to 30° F for six days 20 hours. This is the treatment reported to be recommended for fruit infested with the Mediterranean fruitfly.

Table 1.—Amount and duration of temperatures required to kill cherry fruitfly larvae in processed cherries.

Time Larvae in Storage	Temperature °F	How Processed	Total Larvae	Per Cent Larvae Dead
4 hours at 6 days, 20 hours at	28 30	Unsugared	297	21.21
7 days	20	Unsugared	44	97.68
		Sugared	56	100
7 days	14	Unsugared	42	100
		Sugared	67	100
7 days	8	Unsugared	48	100
		Sugared	36	100
14 days	20	Unsugared	42	97.62
		Sugared	51	100
14 days	14	Unsugared	50	100
		Sugared	46	100
14 days	8	Unsugared	51	100
		Sugared	35	100
21 days	20	Unsugared	51	100
		Sugared	50	100
21 days	14	Unsugared	49	100
		Sugared	46	100
21 days	8	Unsugared	30	100
		Sugared	20	100

Storage temperatures together with duration of exposure are given in table 1. These data show that the treatment reported for the Mediterranean fruitfly would not be practical for the cherry fruitfly. No larvae, however, survived treatments of 14° F or lower for durations of one week or more. It is also interesting to note that no larvae survived cold storage treatments where cherries had been sugared.

S. C. Jones, *Oregon Agricultural Experiment Station, Corvallis.*—2-15-37.

Sulfated Higher Alcohol to Control Scale Insects on Greenhouse Plants.—One year's experience has shown that it is possible to control both shield scales and soft scales on greenhouse plants with sulfated higher alcohol. Best results have been obtained with a dosage of 6 ounces (powder) to each 10 gallons of water. It is necessary to make several applications spaced at intervals of two to four weeks. Where plants are washed with water under pressure within 24 hours following each application old scales are removed and the appearance of the plants are improved. To date no injury to plants has resulted from repeated applications of the sulfated higher alcohols.

E. I. McDaniel, *Michigan State College, East Lansing.*—2-15-37.

Observations on the Life History of *Paratrioza cockerelli* (Sulc) in Southern California.—The following observations upon the potato psyllid, *Paratrioza cockerelli* (Sulc), were made at Santa Ana, Calif., during April and May 1931, while the writer was employed as assistant in entomology and parasitology at the University of California.

The insects were kept in lantern-globe cages having tops of cheesecloth or fine-mesh wire screen. A twig of pepper (*Capsicum*) or tomato (*Lycopersicum*) plant was inserted

through a hole in a cork which was fitted in a small bottle of water, the space between the stem and the cork was plugged with cotton, and the whole was placed in the cage. Under these conditions the twigs kept fresh for a long time. Pepper twigs were used in most cases, since it was found that the female did not deposit so many eggs and the young nymphs did not seem to be able to do so well on the pubescent surface of tomato leaves. The cages containing the insects were placed in the insectary under natural conditions of humidity and temperature.

This insect has been cited a number of times in literature since its description in 1909. Most of the references deal with its systematic position or are brief notes on its presence and relation to the potato yellows disease. The most important references to the life history of the insect are the papers of Compere (Calif. Mo. Bull. **5**:189–91. 1916), Essig (*Jour. Econ. Ent.* 10:(3)433–9. 1917), and Knowlton & Janes (Ann. Ent. Soc. Amer. **24**:283–90. 1931), all of which describe and figure the various stages.

Table 1.—Data on oviposition by the potato psyllid.

No.	Total No. Eggs Laid	No. Eggs Laid per Day			Oviposition Period	Length of Adult Life
		Min.	Max.	Av.	Days	Days
1	472	3	45	14.9	*	
2	431	3	48	14.9	*	
3	741	1	46	16.5	45	45+
4	109	19	33	15.6	*	
5	153	8	38	5.7	*	
6	278	1	30	15.4	18	24+
7	200	1	40	12.5	16	21
8	564	2	55	16.6	34	41
9	179	3	28	9.4	19	28
10	467	11	44	15.1	31	40
11	417	1	43	13	32	38
Average†	*406.6*	*2.8*	*42.1*	*14.1*	*27.8*	*33.8*

* Female escaped.
† Averages of only those females that completed their oviposition period.

The eggs are elongate, yellow, and supported upon a short stalk or stipe. On pepper foliage they are laid along the edges of the leaves, relatively few being scattered over the leaf surface, but upon tomato they are laid wherever the pubescence is thin enough to permit it. Out of a total of 788 eggs laid by several females, 92, or 11.67 per cent, did not hatch. The incubation period for 91 eggs ranged from 7 to 11 days, with an average of 8.7 days.

When the nymph hatches it is attached to the egg by a very fine coiled thread, presumably to prevent it from being blown away or shaken from the plant before it can make its way down the egg stalk and secure a hold upon the leaf surface. In spite of this, mortality is very high among nymphs in the first stadium. Of the 696 eggs that hatched, only 388, or 55.75 per cent, survived to enter the second stadium. Once the nymphs have undergone the first molt the mortality decreases although it remains high. Of 176 eggs from various females, 52 adults were reared, a total loss of 70.5 per cent from egg to adult.

Judging from the limited data at hand, there appear to have been but three nymphal instars, but although the observations were carefully made, it is possible that one molt might have been missed.

There is a great deal of variation among individuals, even in nymphs kept upon the same twig, in the time required for development from egg to adult. Eggs that hatched upon the same day required from 29 to 34 days to complete the life cycle. Of 267 adults reared in the insectary, this period ranged from 19 to 42 days, with an average of 31.2 days. There seems to be little or no difference in the length of time required by the two sexes.

Of 545 adults reared in the insectary, 339 were males and 206 females, giving a sex ratio of 62 to 37, or approximately 3 to 2. Oviposition data on 11 females reared in the insectary are given in table 1.

Females will sometimes mate within an hour or two after emergence, but it is believed that normally 24 hours or more elapse before mating. Females reared in the insectary were placed in cages, each with a male, and mating usually occurred the second or third day after emergence. The first eggs were laid two to eight days after emergence, or from 1+ to six or seven days after mating, the average number of days from the time of caging pairs together until the first egg was found being six days.

A. C. Davis, *U. S. Department of Agriculture, Bureau of Entomology and Plant Quarantine*
—1-7-37.

***Paratrioza cockerelli* (Sulc) on Tomatoes in Southwest Texas.**—An infestation of the tomato psyllid, *Paratrioza cockerelli* (Sulc), was found for the first time in the Winter Garden area of Texas during the fall of 1936. The insect bred on tomatoes during October and November, causing noticeable damage in several localities. Nymphs and eggs were present in most places, sometimes in abundance. Adults were found in every tomato field examined. The species was widely distributed in Maverick, Dimmit, Zavala and Webb counties.

Identification of the insect was confirmed by Dr. R. K. Fletcher, entomologist, Texas Experiment Station, and C. F. W. Muesebeck of the U. S. National Museum.

M. J. JANES, *Texas Agricultural Experiment Station, Winterhaven.*—3-4-37.

Some Notes on *Bruchus brachialis* Fahraeus.—The first examples of this bruchid taken by the writer were collected near Haddon Heights, N. J., June 24 and June 30, 1930, and May 9, 1931, one on each date. These were discovered in unworked collections after the publication of the paper dealing with the occurrence of the insect in this country (Jour. Ag. Res. **46**(8):739–51. 1933). No collecting to the north or east of Washington, D. C., had been done by the writer previous to the spring of 1930.

Adult bruchids or infested pods are at hand from the following localities from Virginia northward:

Virginia.—Centerville and Fairfax, Fairfax county, June 12, 1932.

District of Columbia.—June 11, 1932.

Maryland.—Silver Spring, Montgomery county; College Park, Prince Georges county; Elkridge, Howard county; Rosedale, Baltimore county; and Aberdeen, Harford county; all June 11, 1932. Salisbury, Wicomico county, July 15, 1931. Hurlock, Dorchester county, July 12, 1932. Easton, Talbot county, July 12, 1932.

Delaware.—Felton, Kent county, July 1, 1931. State Road and Glasgow, New Castle county, June 7 and June 13, 1932. Delmar, Sussex county, June 7, 1932.

Pennsylvania.—New Hope, Bucks county, June 18, 1933. West Grove, Chester county, June 8, 1934.

New Jersey (First county records only).—Burleigh, Cape May county, July 23, 1931. Newtonville, Atlantic county, June 27, 1931. Millville, Cumberland county, July 2, 1932. Pennsville, Salem county, June 7, 1932. Thorofare, Gloucester county, June 7, 1932. Haddon Heights, Camden county, June 24, 1930. Vincentown, Burlington county, June 20, 1931. Seaside Heights, Ocean county, June 17, 1934. Pennington, Mercer County, June 18, 1933. Delaware, Warren county, June 19, 1933.

At Haddon Heights, N. J., less than 1 per cent of the seeds of several volunteer plants of bird vetch, *Vicia cracca*, produced adult bruchids. Woolly-pod vetch, *V. dasycarpa*, was rather heavily infested, one count showing that approximately 56 per cent of the seeds produced bruchids.

Limited oviposition of *B. brachialis* in the field has been obtained on pods of Hungarian vetch, *V. pannonica;* common vetch, *V. sativa;* purple vetch, *V. atropurpurea;* and one of the perennial sweet peas grown from seed sold commercially under the name *Lathyrus latifolius*. Not more than six eggs were found on *Lathyrus* plants. Infested pods of the vetches with few exceptions had from one to five eggs each. These eggs hatched normally and although some of the young larvae actually entered the seeds all failed to develop. Therefore, no emergences have been obtained from these four plants by the writer.

The earliest dates noted for the appearance of the overwintering adults in New Jersey for four different years were April 29, May 9, May 10 and May 18. October 10 was the latest date on which the bruchid has been collected in the field. Adults have been taken on flowers of milkweed, rhubarb, spiraea and wild carrot. One was beaten from oak on May 25, and several were collected during May in a Japanese beetle trap with a geraniol-eugenol bait. The writer has been unable to locate hibernating adults.

Live bruchids were taken from unopened pods of hairy vetch in a rearing jar on June 2, 1932, the material having been collected June 29, 1931.

L. J. BOTTIMER, *U. S. Department of Agriculture, Food & Drug Administration.*—1-30-37.

Strawberry Leaf Roller Parasites.—During 1935 a study was made of the parasites attacking two species of strawberry leaf rollers in northern Utah. The parasites, *Exochus pleuralis* Cress., *Cremastus cookii* Weed., *Elachertus cacoeciae* How., *Catalaccus aeneoviridis* Gir., *Spilochalcis delumbis* (Cress.), *Microdontomerus anthonomi* Cfwd., *Apanteles* (?) *aristoteliae* Vier., *Microgaster comptanae* Mues., *Chelonus phthorimaeae* Gahn., and *Goniozus platynotae* Ashm., were reared from the strawberry leaf roller, *Ancylus comptana fragariae*

Walsh & Riley. Parasites reared from *Anacampsis fragariella* Busck were *Euochus pleuralis* Cress., *Spilochalcis delumbis* (Cress.) and *Goniozus platynotae* Ashm. (Det. C. F. W. Muesebeck, A. B. Gahan and R. A. Cushman.)

Through the cooperation of W. H. White and Dr. C. P. Clausen, of the U. S. Bureau of Entomology and Plant Quarantine, two cages, containing 300 females and 200 males of *Macrocentrus ancylivorus* Rohwer, were received from the east. The parasites in one cage were released in a large leaf roller-infested strawberry patch at Providence (Cache county), July 12, 1936, and those in the other cage were released on the following day at Orem (Utah county). Only eight individuals were not in vigorous condition when the releases were made. In addition, 1000 females and 500 males of *Cremastus cookii* Weed. were received, releases being made in infested strawberry patches at Providence and Hyrum (Cache county) on July 12, and at Brigham City (Boxelder county), North Ogden (Weber county), Clearfield and Farmington (Davis county), American Fork and Pleasant Grove (Utah county) on July 13, 1936. One specimen was collected several days after release at a trap light in Farmington.

GEORGE A. KNOWLTON, *Utah Agricultural Experiment Station, Logan.*—12-24-36.

Breaking the Dormancy in the Sugar-beet Webworm, *L. sticticalis* L., by Means of Chemicals.—Under average conditions 92 to 95 per cent of the first-generation larvae of the sugar-beet webworm pupate during the latter part of June and early July. The adults emerge in a week to 10 days and under favorable conditions a second brood occurs. In some years a partial third generation occurs in Montana but it is of no conse-

Table 1.—Chemical treatment of sugar-beet webworm larvae.

CHEMICAL	CONCENTRATION Cc. per Liter	PER CENT PUPATED IN 10 DAYS
Xylol	.016	100
Carbon tetrachloride	.078	80
Di-ethyl ether	.062	70
Ethylene dichloride	.057	70
Ethyl bromide	.027	60
Ethyl iodide	.001	44

quence since cold weather terminates it before the larvae have a chance to develop. The remaining 5 to 8 per cent first-generation larvae enter into a dormant prepupal stage, in which they remain until the following spring.

Experiments have shown that high temperatures over a period of six months have no effect in breaking this dormancy. However, if the temperature is gradually lowered to below freezing and the larvae are held at this low temperature for several days this dormant period is broken and pupation occurs. It has also been shown that if the prepupae are subjected to chemical treatment, the same result may be obtained in a much shorter period.

Observations on the fat bodies during these stages show that they are well developed in the larvae, and that just prior to pupation they are digested and appear as a yellow oily liquid. If they go into the prepupal stage the fat bodies apparently remain unchanged. When this dormant period is broken they again become liquefied, as in the previous case. In both cases they reappear, well developed, in the adult. These changes appear to be the same whether the larva pupates at the end of its normal larval period or whether it pupates following the breaking of dormancy by either low temperatures or chemical treatment. In view of the above it is possible that the activating of the fat-digesting enzymes may be a strong factor in preventing or breaking down dormancy.

The results obtained by chemical treatment were arrived at by subjecting the prepupae for a period of six hours at 27° C to the various chemicals at the concentrations listed in table 1. In some cases a number of trials had to be made in order to obtain a concentration which did not prove lethal to any of the specimens. Strand fumigation flasks of 6.4-liter capacity were used and the chemicals measured by means of a micropipette. After treatment the prepupae were held at 27° C. Since no pupation occurred after the tenth day this time is listed as the standard.

Checks held at 27° C showed no pupation. A large series held at this temperature for six months did not produce a single pupa.

It is also interesting to note that in parasitized prepupae, which had been parasitized in the larval stage, the parasite emerged within this 10-day period, but in every case they were very immature and were unable to pupate.

J. H. PEPPER, *Montana State College, Agricultural Experiment Station, Bozeman.*—1-19-37.

Parasites of Larch Sawfly in Western Montana and Great Lakes Region.—During the summer of 1935 George R. Hopping of the Canadian Entomological Branch noted an outbreak of the larch sawfly, *Nematus ericksonii* Hartig, in the Flathead Basin just north of the boundary between the United States and Canada. J. C. Evenden visited the Flathead National Forest, Montana, later in the season and found a rather severe infestation of this species along the north fork of the Flathead river. The larch sawfly was known to be present in the Great Lakes region of the United States, where at times it was heavily attacked by parasites, particularly the imported ichneumonid *Mesoleius tenthredinidis* Morley and the native tachinid fly *Bessa selecta* Meig. It was therefore considered worth while to study the parasitization at both localities with the idea of transferring important beneficial species from one region to the other if they were not present in both. Mr. Evenden collected 4000 cocoons from the Flathead National Forest and L. W. Orr made six collections of several hundred cocoons each at several points in Michigan, Wisconsin and Minnesota. The material was sent to the laboratory of the Division of Forest Insect Investigations at New Haven, Conn., for rearing and it was found that *Mesoleius tenthredinidis*, *Bessa selecta* and a chalcidoid, *Dibrachys* n. sp., were present in both regions. Four specimens of Cryptinae, representing three species, *Stylocryptus* sp., *Phygadeuon* sp. and *Aenoplex* n. sp., emerged from the Montana material but did not appear from that of the Great Lakes region, and four specimens of another cryptine, *Pezoporus indistinctus* (Prov.), and a few specimens of a species of *Dibrachys* appeared in the collections from the Great Lakes region but were not reared from cocoons collected in Montana. *Mesoleius tenthredinidis* was a very important parasite in certain areas of the Great Lakes region, and present in appreciable numbers in western Montana. *Bessa selecta* was of less importance in both regions. *Dibrachys* n. sp., was important in western Montana but apparently of little significance in the Great Lakes region.

P. B. Dowden, *U. S. Department of Agriculture, Bureau of Entomology and Plant Quarantine.*—11-20-36.

Correction—Methyl Bromide Fumigation of Codling Moth Larvae [Jour. Econ. Ent. 29(6):1174. Dec.].—The commercial product used in controlling codling moth larvae contained 3.4 per cent methyl bromide and 96.6 per cent carbon dioxide by volume when expanded as a gas, or 7 per cent methyl bromide by weight. This used at the rate of 5 pounds per 100 cubic feet under vacuum conditions gave a complete kill of the codling moth larvae buried in sacks. Five pounds of this material contains approximately 5.5 ounces of methyl bromide.

David L. Lindgren, *University of California Citrus Experiment Station, Riverside.*—1-18-37.

Provision has been made in 1937 quarantines of Arizona and California for conditional entry of host plants of the peach mosaic disease from infected areas. As a condition of certification the host plants and budding wood must have been produced on premises having a disease-free radius of 5 miles for at least a year as determined by competent inspection prior to June 30 each summer.

Issuance of an alfalfa weevil quarantine on the part of the Kentucky Agricultural Experiment Station on January 22, 1937, brought the number of states having such quarantines to 28. Montana and Washington recently lifted restrictions as to the entry of potatoes from the weevil-infested areas, Nebraska lifted all restrictions as to host material from Mendocino county, Calif., and added counties in other states to the regulated areas; and Illinois extended the regulations to apply to new areas.

Washington state fumigating requirements for potatoes shipped from the areas infested with the potato tuber moth were modified on January 22, 1937, to provide for a choice of one of three formulas under a revision of Quarantine Order 20. The same formulas are provided for fumigating tomatoes and tomato plants shipped from areas infested with the tomato pinworm, under Quarantine Order 24 issued on the same date. Fumigation is required under both quarantines only in the absence of inspection.

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BUGABOO OR BACKBONE?

ARE we as entomologists too supine? Do we accept without resistance the arbitrary dictates of other agencies as to what control measures we shall employ and recommend? Must we permit non-entomological agencies to shape the future of economic entomology?

In the matter of insecticides have we not, for example, yielded too docilely to the arguments incited by exaggerated fears regarding the dangers from arsenical residues? It is true that apples, cabbages and other food products as offered for sale often carry an amount of arsenic, lead or fluorine that, were it all consumed, might be injurious to health or even fatal to an occasional careless consumer. But what are the prospects that the entire arsenical residue will be ingested? Every entomologist knows that the greater part of the residue is borne by those parts of the fruits and vegetables which are discarded.

How many cases are proved of death from spray residues on human foods? Careful analysis of this matter will doubtless show that the danger of death from spray residues is about in the class of hazard of being killed by a golf ball or by falling out of bed. Disasters from the consumption of alcohol render the danger from spray residue microscopic in comparison. People are killed or crippled every week by slipping on polished floors far in excess of the numbers who expire from spray residues on food. So far, no law fixes a "smoothness tolerance" for floors in public or private buildings, but the federal Insecticide Division is said to spend the majority of its appropriation ferreting out violations of spray residue tolerance.

I am concerned over the tendency of entomologists to abandon our most effective insecticides because of fear out of proportion to their menace to life and health and before we have adequate substitutes. Some entomologists say that we must not recommend carbon disulfide to be used by any but experienced fumigators. Yet nearly every person uses gasoline, and handles it without restriction except that it be transported in red cans. Illuminating gases are piped into every home. Refusing to recommend carbon disulfide as a fumigant is in a class with denouncing kerosene lamps or lanterns because they may explode or be overturned and set fire to buildings. No one has yet proposed to outlaw the use of natural gas because of the recent school tragedy in Texas. If 450 school children had been killed by fumigating with hydrocyanic acid there would be a demand by the public, with acquiescence by the entomologists, to prohibit so deadly and dangerous a gas.

My point is not to suggest ignoring the danger from these materials, but, because of their value, to recommend their use with all necessary precautions.

The question has been asked, why not use the relatively nontoxic organic sprays, dusts and fumigants, instead of the poisonous materials? My answer is: by all means, *when and if* we discover equally effective means. I do not believe that time has yet arrived. I do not believe that anyone can challenge the proposition that carbon disulfide is the most effective fumigant known, where great penetration is required, and that arsenate of lead is the most satisfactory foliage spray ever discovered for chewing insects. In the case of fumigants nothing short of 100 per cent destruction of the pest is satisfactory; and I do not believe that a single one of the newer type of fumigants will give such control except in vault fumigation. The organic stomach poisons, rotenone and the like, are practically all fugitive, temperamental, unstable, almost impossible to standardize, subject to serious deterioration with age and climatic influences. I would not lessen in the slightest degree the search for newer, safer, better materials, and I have the highest admiration for the work which research entomological chemists have done and are doing in developing better insecticides. On the other hand, I would not placidly accede to the abandonment or restriction of what we have until this intensive search has revealed the panacea.

It is human nature to ignore the dangers of the familiar and the commonplace and to exaggerate the fear of the unknown and mysterious. Unfortunately, entomology comes close to the latter. Consequently, we must not be misled by the violence of the clamor and complaint aroused by an occasional accident from insect poisons. Every entomologist knows that the house fly is a hundred times more dangerous to man than the black widow spider; but which receives the newspaper publicity? In spite of tremendous progress made in popularizing entomology in the last two decades, perhaps our biggest task is still to make entomology better known, more familiar, and the necessity for control of insects better understood.

No one advocates the needless endangering of human life through the use of insecticides. On the contrary, the possibilities of injury must be explored and guarded against by careful use and education. But the oftentimes unreasonable exaggerations of danger should be met with refusal to give up, on poorly substantiated grounds, our most powerful chemical weapons against insects. I propose that, instead of submitting to withdrawal of every trump card that years of patient research have dealt us, we emphasize to our clientele the cautions necessary to safe use of these trumps. Every entomologist has fumigated with carbon disulfide and hydrocyanic acid scores of times without mishap. Others can do so, if they use proper precautions. "But," someone objects, "people are careless and you lay yourself open to blame every time you advise such measures." So are people careless about crossing streets, about using disinfectants, and about taking medicines prescribed by physicians; but we do not prohibit the use of automobiles, or prevent the sale of bichloride of mercury, or hold the physician responsible for misuse of his prescriptions. If we are careful to emphasize the necessary precautions, and they are ignored, no more should we be held responsible or our recommendations deemed unworthy.

I think we have been too easily bluffed, too prone to allow the time-

tested remedies to be taken from us, while we have chased the fantasy of some newer, better, perfect (?) insecticide. We have been too fearful of adverse criticism from the public. The moment a shadow of objection to our procedures has appeared on the lawn of public opinion, we have scuttled to cover, like a frightened barnyard fowl. I plead for a more militant entomological fraternity!

C. L. METCALF.—3-22-37.

Reviews

The Gypsy Moth, *Porthetria dispar* L., in Eurasia, Africa and New England, by Dr. Karl E. Schedl, Institute for Applied Entomology, München, Germany. 1936. 242 pp., 95 figs., 26 tables, German text. Paul Parey, Berlin, S.W. 11, Hedemannstrasze, 28 and 29.

Doctor Schedl's work on this important pest is further evidence of a growing and highly desirable tendency among biologists to recognize the urgent need for occasional critical summaries of the world literature concerning the bionomics and economics of important insects. The mass of original matter published in entomology is now nothing short of overwhelming, since several thousands of miscellaneous articles make their appearance every year and no formal plan for digesting and systematizing the results has been considered or established by the profession. Summaries of the scattered literature not only make the known facts conveniently available to students and professional workers but provide the vantage point for new perspectives and stimulate further research.

The present extensive and valuable summary may well be taken as a model for monographs on economic species. After a brief consideration of nomenclature, sections are devoted to genetics, geographical distribution, food plants, history and present status in New England, methods of feeding and injury, degree of damage to trees of various species, chronological list of outbreaks with reference to intensity and periodicity, annual development and climatic factors, habits of the several stages, biotic potential and environmental resistance versus population, parasitic and predacious insects, bacterial and fungous diseases, preventative measures and controls. Somewhat more space is devoted to the bionomics and utilization of insect enemies and ecological effects on development of the host and its enemies than to other phases. The text is well and clearly illustrated with curves, representing the relation of time and temperature to development, maps showing the distribution of the host and its parasites and predators, figures of the natural enemies and tables of data concerning importation and colonization of the parasitic and predacious insects.

The information contained in the monograph represents the essence of exactly 600 original articles, whose titles are listed in full in alphabetical order and by number in a separate section at the end of the paper. No effort seems to have been spared to present a complete, reliable and logical account of the bionomics and economics of this destructive moth. This work will prove to be a very useful reference, and should perhaps be translated into the English language in order to increase its availability to American entomologists. The addition of a detailed classified index would have been desirable, but the table of contents is fairly comprehensive and contains page references that take the place, in a measure, of an index.

W. V. BALDUF.—2-26-37.

Recent Advances in the Control of the Pink Boll Worm, *Platyedra gossypiella* Saunders, by Natural Enemies, by Dr. M. Kamal. *Extrait du Bulletin de la Société Royale Entomologique d' Egypte*, Année 1936, pp. 259–92. 2 charts, 10 pl.

Along with the Egyptian cotton worm, *Prodenia litura*, the pink bollworm and the spiny bollworm, *Earias insulana*, constitute the major cotton pests of Egypt. Before the advent of *Platyedra* about 1912, *Earias* was the most important insect enemy of cotton, but, says the author, "since this worm is known to breed the year round without decided overwintering forms, the campaign staged to control the pink bollworm, particularly the ordinance which establishes a closed season and regulates the uprooting of cotton stocks and other malvaceous plants standing in the field, thus producing a lack of food supply in winter,

has resulted in subduing the *Earias* and rendering it an insect secondary in importance to the pink bollworm."

Platyedra generally becomes noticeable in the field with about 5 per cent infestation in June, which increases to some 20 per cent in August and probably 50 to 60 per cent in September, after which almost every boll will be attacked, the seasonal infestation being remarkably regular year after year. Some interesting calculations of acre-populations, based on these monthly percentages of infestation, are given. For instance, with an average infestation of 15 per cent early in August, the *Platyedra* larval population works out at about 115,000 per acre, increases to just above 400,000 in September and reaches its peak with around 1,250,000 in October, when cropping becomes well advanced. Dr. Kamal's breeding records give an average oviposition of only about 50 eggs per moth, although figures five or six times that high have been reported elsewhere.

Platyedra in Egypt is attacked by numerous parasites and predators, most prominent among the former being braconids, ichneumonids, chalcids and bethylids, while the writer considers that such predators as the coccinellids, chrysopids, *Triphleps*, staphylinids, carabids and spiders play but a minor role in natural control. Most of the parasites are larval feeders only, attempts to increase the efficiency of the local egg parasite *Trichogramma evanescens* and the introduction of *T. minutum* through the Farnham Royal laboratory proving largely abortive.

Unfortunately, the domestic parasites become manifest only very late in the season—usually about October—"when the reproductive potential of the host has reached its maximum and the population is declining." Attempts at laboratory breeding and early field distribution of the two principal ones, *Pimpla roborator* and *Microbracon brevicornis*, having given discouraging results for three years, *Microbracon lefroyi* was introduced from the Punjab, after the *M. kirkpatricki* reintroduced by Alfieri from Kenya in 1927 did not appear to be able efficiently to establish itself in Egypt. *M. lefroyi* commonly attacks the spiny bollworm in India, but has been found to breed on *Platyedra* in Egypt. Also *Microbracon mellitor*, recently introduced from Hawaii, has bred readily on *Platyedra* larvae and multiplication has been rapid. As it accepts other lepidopterous larvae as hosts, this parasite is regarded by Dr. Kamal with high hopes as being capable of becoming permanently established in Egypt. Several releases have already been made and these will be greatly increased in volume this year.

With the good paper and excellent type characteristic of the Royal Entomological Society's publications, the charts showing relative seasonal abundance and the clear illustrations of *Platyedra*, its parasites and the breeding methods employed, this is an interesting progress report on the biological control of the pink bollworm in Egypt.

ARTHUR H. ROSENFELD, Giza, Egypt.—2-24-37.

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A correction has been made by the Comstock Publishing Company in their "The Biological Control of Insects," by Harvey L. Sweetman, which was reviewed by Harry S. Smith in the February JOURNAL. Notice has been received from the company that in all copies of the book now being distributed the correct print of Dr. W. R. Thompson is being pasted over the picture in error which Dr. Smith noted. Those who have already purchased the book may obtain the correct print free by addressing W. S. Schaefer at the publisher's office, 124 Roberts Place, Cornell Heights, Ithaca, N. Y.

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Obituary

A. J. Ackerman 1889–1937

With the death of A. J. Ackerman, February 27, 1937, the Fruit Insect Division of the Bureau of Entomology and Plant Quarantine lost one of its oldest field workers, from the standpoint of period of service. Mr. Ackerman was born at Worcester, Mass., October 5, 1889, graduated from the Massachusetts Agricultural College in 1912, and received an M.S. degree from the same institution in 1914. On July 1 of the same year he entered the then Deciduous Fruit Insect Division, serving at West Chester, Pa., from 1914 to 1916; at Benton Harbor, Mich., in 1917; at Bentonville, Ark., from 1918 to 1933, and at Vincennes, Ind. until his death. The work at Bentonville was interrupted in 1921, when Mr. Ackerman was assigned for a season to work on codling moth control and spray residue on pears in California.

Mr. Ackerman is best known for his work with lubricating-oil emulsions for the control of the San Jose scale, which was carried on in Arkansas for several years, beginning in late 1921. At that time a serious outbreak of San Jose scale occurred, for the control of which the standard lime sulfur appeared inadequate. His work with lubricating-oil sprays enabled many growers in the middle west to save orchards which had appeared doomed. Mr. Ackerman also made extensive studies of the biology of a number of species of leafhoppers on apple and grape, and during recent years gave practically all of his attention to the codling moth problem.

B. A. PORTER.—3-22-37.

Current Notes

NORTH CENTRAL STATES ENTOMOLOGISTS SIXTEENTH ANNUAL MEETING

Six sectional and two general programs marked the sixteenth annual meeting of the North Central States Entomologists, March 4 and 5 at Kansas City, Mo. Seventy phases of entomological research and practices were scheduled for discussion in the various sessions, which convened in the Baltimore Hotel.

There was also a business meeting at which reports of committees and discussion of the meeting place for 1938 were heard. The Central Plant Board met March 3 and a banquet for all members took place Thursday evening, March 4.

Sectional programs were on grasshopper research and control, household insects and their control, white grub research and control, insects attacking fruit and truck crops and shade trees, control of insects in stored grain and cereal products, and apiculture.

A symposium, "The relation of the new federal and state conservation programs to economic entomology," was a feature of the general program, Friday morning, March 5. It included discussions of the soil conservation program, wildlife conservation program, relation of beekeeping to wildlife and soil conservation programs, and agriculture conservation program.

The extensive list of subjects for discussion was programmed by George A. Dean, chairman of the committee, assisted by W. P. Flint and R. T. Cotton.

MR. E. GRAYWOOD SMYTH, entomologist for the W. R. Grace & Company sugar estates, has recently returned to Peru from an extended vacation in the States, where he visited entomologists, museums and experiment stations on the west coast and in the east. He spent some time on his ranch in California studying the possibility of the commercial growing of pyrethrum, and later drove across the country to New York.

NEW JERSEY MOSQUITO EXTERMINATION ASSOCIATION ANNOUNCES PUBLICATION OF PROCEEDINGS—1937 MEETING

Application for copies of the 1937 proceedings of the annual meeting of the New Jersey Mosquito Extermination Association at the minimum rate will be accepted up to May 10. Remit (75 cents per copy) to the secretary, Dr. Thomas J. Headlee, New Brunswick, N. J.

The usual review of mosquito control work throughout the world will be included. Publication is scheduled for June 10, 1937.

* * *

JOHN T. BIGHAM, of Menard, Tex., was erroneously reported at the December 1936 Association meeting as being among those who died during the year. The Association regrets the mistake, with apologies to Mr. Bigham.

* * *

Horticultural Inspection Notes

A CONFERENCE was held in Washington, D. C., on December 15, 1936, to consider the desirability of requiring the treatment under the provisions of the Nursery Stock, Plant, and Seed Quarantine No. 37, of all known bulb nematode hosts intended for propagation and not at that time being treated as a condition of entry. The evidence presented at the conference indicated that the bulb nematode risk which accompanies the importation of most ornamental bulbs which have been inspected in the country of origin, supplemented

by inspection at the port of entry in the United States, does not, according to the Bureau of Entomology and Plant Quarantine, justify the requirement that all known hosts be treated as a condition of entry. No change in the requirements as to importation of narcissus bulbs is announced at this time.

REPORT OF THE CENTRAL PLANT BOARD

The Central Plant Board held its thirteenth annual meeting at the Baltimore Hotel in Kansas City, Mo., on March 3, 1937, in conjunction with the North Central States Entomologists. L. M. Gates of Nebraska was elected President. P. T. Ulman of Indiana was re-elected Secretary-Treasurer and E. L. Chambers of Wisconsin was re-elected as Representative of the National Plant Board. The program follows:

Report of Secretary-Treasurer ..... P. T. ULMAN, Indiana
President's Address ..... A. G. RUGGLES, Minnesota
Report of Representatives on National Plant Board ..... E. L. CHAMBERS, Wisconsin
The Corn Borer Situation in the Central States ..... P. N. ANNAND, U.S.D.A.
The Developments in the Alfalfa Weevil Situation ..... J. D. HAMLIN, Utah
Is a Second Inspection of Red Raspberries Necessary to Hold Virus and Other Diseases and Insects to a Minimum? ..... T. L. AAMODT, Minnesota
White Pine Blister Control Area Permit Tags and Regulations ..... E. L. CHAMBERS, Wisconsin
The Chestnut Blight Situation in Illinois ..... H. F. SEIFERT, Illinois
Virus Diseases of Plants ..... L. E. MELCHERS, Kansas
The Status of the Phony Peach Disease ..... S. A. ROHER, U.S.D.A.
Southern Vegetable Plant Situation ..... PAUL H. MILLER, Arkansas
Tomato Seed Certification and Southern Plants ..... R. W. SAMSON, Indiana
Gladiolus Diseases and Insects ..... P. T. ULMAN, Indiana
Report of Committees
Uniform Regulations ..... J. C. DAWSON, *Chairman*, Missouri
Standing—Quarantine ..... DR. CARL J. DRAKE, Iowa

MOTIONS

That we view the pin worm situation of tomatoes in California with great alarm and keep informed as to any possibility of this insect becoming a menace in the Central States but take no regulatory action at this time.
[Moved by A. G. Ruggles. Adopted unanimously.]

That inasmuch as Dr. Drake has been following the national weed control program, that he be appointed as a committee of one to keep in touch with the biological control of weeds and report to the Board at the next annual meeting.
[Moved by P. T. Ulman. Adopted unanimously.]

That due to the seriousness of the Dutch elm disease and the inadequacy of the present appropriation to cope with the situation, that the Central Plant Board go on record as being in favor of respectfully requesting Congress to appropriate 3 million dollars for the Dutch elm disease eradication work.
[Moved by Frank N. Wallace. Seconded and adopted unanimously.]

That $500,000 be respectfully requested from the Congress of the United States for Japanese beetle control work instead of $300,000 formerly appropriated, as it is believed that $300,000 is inadequate to do the necessary work in checking and controlling the spread of this series insect pest.
[Moved by J. C. Dawson.]

REPORT OF RESOLUTIONS COMMITTEE

WHEREAS, The Central Plant Board has enjoyed excellent facilities and a fine program, therefore, be it

RESOLVED, That we extend our thanks and appreciation to the hotel management, program committee, arrangements committee and others who have contributed to the success of the meeting.

WHEREAS, The Bureau of Entomology and Plant Quarantine of the U. S. Department of Agriculture has made a notable contribution to our knowledge of the possibilities of transporting alfalfa weevil in shipments of baled alfalfa hay, therefore, be it

RESOLVED, That the Central Plant Board express its appreciation for the cooperation given in securing this valuable information which is of particular interest to a number of states at this time.

WHEREAS, The tomato canning industry of the United States is largely dependent on southern grown plants to set their acreage, and

WHEREAS, Tomato diseases are greatly reducing the crop in tomato producing states and making serious inroads into a raw crop industry that has a 30 to 40 million dollar cash value, and

WHEREAS, The diseases appearing in the field are generally transmitted to the field crop through the seed and plants used, therefore, be it

RESOLVED, That the Central Plant Board respectively request and urge the Congress of the United States to appropriate $30,000 for tomato disease investigation work, both in the plant producing states and in the tomato and seed producing states.

WHEREAS, The work that the Bureau of Entomology and Plant Quarantine is doing in enforcing federal, foreign and domestic plant quarantines is of great importance in preventing the introduction and spread of insect pests and plant diseases into the Central States, and

WHEREAS, The enforcement of foreign plant quarantines is a federal function and must of necessity be done at ports of entry, and

WHEREAS, The inspection of plant material in transit is an important adjunct in the enforcement of various domestic plant quarantines and one in which various states of this group are cooperating, and

WHEREAS, It is necessary that means of enforcing of plant quarantines be strengthened, providing more inspectors at ports of entry and full time inspectors at important transfer points, and

WHEREAS, The President's budget of 1938 includes small increases for the items Transit Inspection and Enforcement of Foreign Plant Quarantines under the Bureau of Entomology and Plant Quarantine, be it

RESOLVED, that the Central Plant Board urge members of Congress to appropriate at least the amount included in the budget and that the Secretary send copies of this resolution to chairman and members of the committees handling the agricultural appropriation bill in the House and Senate.

WHEREAS, It has become a state and national policy to discourage the requirement of fees and bonds for the interstate shipment of nursery stock, and,

WHEREAS, It is the consensus of opinion that the recognition and acceptance of state inspection certificates by other states is essential to the welfare of all growers of plants and the proper functioning and correlation of inspection services between states so as to permit free interstate movement of horticultural and agricultural products, and

WHEREAS, Dormant inspection of nursery stock does not detect virus diseases such as peach mosaic and many other plant diseases and insect pests, and

WHEREAS, Destination inspection of nursery stock will often result in additional delay and damage from exposure as well as additional and unnecessary costs to the consumer and home grower, and

WHEREAS, Plant inspection work is in the interest of all agriculture, both producers and consumers, and the cost of inspection should not be borne by any one group, and

WHEREAS, Certain sections of Colorado House Bill No. 545 and Senate Bill No. 615 are diametrically opposed to present-day trends relating to nursery inspection and quarantine work, and

WHEREAS, The Central Plant Board desires to secure the cooperation of Colorado and all other states in working towards uniform regulations, relating to plant inspection

and plant quarantines, and desires to encourage the friendly relationship between states so that interstate shipments of agricultural products may move without being unnecessarily hampered, therefore, be it

RESOLVED, That the Central Plant Board at its regular annual meeting, March 3, 1937, at Kansas City, Mo., go on record as being strongly opposed to Colorado House Bill No. 545 and Senate Bill No. 615, and that copies of this resolution be sent to the Governor, the Director of the Department of Agriculture, and the State Entomologist of Colorado, and be it further

RESOLVED, That the Secretary be instructed to send the following telegram to the Governor of Colorado:

"Honorable Teller Ammons, Governor of Colorado, Denver, Colorado.

"Central Plant Board in official meeting today Kansas City unanimously passed resolution strongly opposing Colorado House Bill five four five and Senate six one five as being diametrically opposed to present trends relating to interstate movements of horticultural and agricultural products stop Colorado ships to other states cauliflower onion sets lettuce cantaloupes peaches and other plant products often infested with plant lice thrips mites and other insects and plant pests without destination inspection requirements or fees stop Most states accept other state inspection certificates on plant products and feel that Colorado should reciprocate. P. T. Ulman, *Secretary*, Central Plant Board."

L. M. GATES
CARL J. DRAKE
W. A. PRICE

Cotton States Branch

PROCEEDINGS OF THE TWELFTH ANNUAL MEETING

Hotel Plaza, San Antonio, Tex., February 18–20, 1937

The twelfth annual meeting of the Cotton States Branch was held at San Antonio, Texas, on February 18, 19 and 20, 1937. This was a joint meeting with the Texas Entomological Society, the Branch having voted to meet every fourth year with that Society in a city west of the Mississippi river. The attendance was considerably larger than that of any previous meeting of the Branch, there being 113 names on the attendance record, and sessions on three days and two nights were required to complete the full program. Six symposia, dealing with insects of special interest to southern entomologists, were presented. F. L. Thomas led the symposium on "Cotton Insects and Their Control" and C. L. Stracener led the symposium on "Rice Insects and Their Control," both of which were given on February 18. "Parasitic Insects Affecting Animals, with Special Reference to the Screw Worm" was the title of the symposium that was led by W. E. Dove on the afternoon of February 19. A number of ranchmen and others interested in live stock was present for this symposium. The following symposia were presented on the night of February 19: "Truck Crop Insects and Insecticides," led by W. H. White, "Pecan Insects and Their Control," led by S. W. Bilsing, and "Peach Insects and Their Control," led by Oliver Snapp. Considerable informal discussion followed the presentation of each symposium.

Fifty papers were presented during the meeting, classified as follows:

Insects attacking cotton.....22 Insects attacking grass.....2

Insects attacking animals and man	14	Insects attacking pecans	1
Insects attacking fruit	3	Insecticides	1
Insects attacking truck crops	3	Miscellaneous	4

The President of the American Association of Economic Entomologists, F. C. Bishopp, attended the meeting and extended greetings from the parent association with remarks on the Atlantic City meeting. The first vice president of the parent Association, S. W. Bilsing, was also in attendance at San Antonio. Lee A. Strong, Chief, and heads of eight divisions of the U. S. Bureau of Entomology and Plant Quarantine attended the meeting. Greetings were received from G. C. Beckman, the oldest living entomologist in Texas, and from Alfons Dampf, entomologist for the Republic of Mexico. Fred W. Mally, who conducted entomological work under C. V. Riley, gave a very interesting talk on entomology in the nineties. A number of interesting exhibits, expecially on the screw worm and pink boll worm, were installed in the spacious ball room provided for the meeting.

The annual address of the Chairman of the Cotton States Branch was given by W. E. Anderson immediately following the business session on February 18. This was followed by the first session for the presentation of papers with Mr. Anderson presiding.

The annual banquet was held on the night of February 18 with Mr. Strong as toastmaster. He spoke on the work of the Bureau of Entomology and Plant Quarantine. The address on this occasion was made by F. A. Fenton, President of the Texas Entomological Society, who chose for his subject "World Cotton Insect Problems and Their Relation to American Cotton Production."

FIRST BUSINESS SESSION

Thursday, Feb. 18, 1937. 9 a.m.

The meeting was called to order by Chairman W. E. Anderson. The following were present:

C. H. Alden, Cornelia, Ga.
A. H. Alex, San Antonio, Texas.
Leeman Anderson, Harlingen, Texas.
W. E. Anderson, Baton Rouge, La.
O. G. Babcock, Sonora, Texas.
W. J. Baerg, Fayetteville, Ark.
A. I. Balzer, Beaumont, Texas.
T. C. Barber, Brownsville, Texas.
C. O. Barnard, Kansas City, Mo.
W. L. Barrett, Jr., Uvalde, Texas.
W. O. Berry, Harlingen, Texas.
John T. Bigham, Menard, Texas.
S. W. Bilsing, College Station, Texas.
F. C. Bishopp, Washington, D. C.
G. Claude Bond, San Antonio, Texas.
J. M. Brennan, San Antonio, Texas.
Arthur C. Brown, Gainesville, Fla.
Robert W. Burgess, Uvalde, Texas.
R. C. Bushland, Dallas, Texas.
J. A. Cavanagh, Midland, Mich.
A. J. Chapman, Presidio, Texas.
W. F. Cherry, Louisville, Ky.
S. W. Clark, Weslaco, Texas.
R. C. Collins, Freeport, Texas.
R. P. Colmer, State College, Miss.
R. T. Cotton, Manhattan, Kansas.
J. M. Del Curto, Austin, Texas.
Wm. Dickison, Houston, Texas.
Kelvin Dorward College Station, Texas.
W. A. Douglas, Crawley, La.
W. E. Dove, San Antonio, Texas.
Jim R. Dutton, Washington, D. C.
Craig Eagleson, Dallas, Texas.
C. O. Eddy, Baton Rouge, La.
L. O. Ellisor, Baton Rouge, La.
K. P. Ewing, Port Lavaca, Texas.
John R. Eyer, State College, New Mexico.
Alfred Fenton, Houston, Texas.
F. A. Fenton, Stillwater, Oklahoma.
Robert K. Fletcher, College Station, Texas.
B. M. Gaddis, Washington, D. C.
J. C. Goodwin, Gainesville, Fla.

R. W. Harned, Washington, D. C.
G. G. Harris, San Antonio, Texas.
Ephriam Hixson, Stillwater, Oklahoma.
P. A. Hoidale, Harlingen, Texas.
R. V. Hood, Corpus Christi, Texas.
Wm. R. Horsfall, Fayetteville, Arkansas.
J. W. Ingram, Houma, La.
M. J. Janes, Winter Haven, Texas.
H. A. Johnston, College Station, Texas.
M. P. Jones, Washington, D. C.
M. S. Jones, San Antonio, Texas.
Eleanor King, San Antonio, Texas.
E. F. Knipling, Edinburg, Texas.
E. Klappenbach, New Braunfels, Texas.
E. W. Laake, Dallas, Texas.
C. F. Ladeburg, Orlando, Fla.
Harry Landa, San Antonio, Texas.
J. B. R. Leary, Laredo, Texas.
A. W. Lindquist, Uvalde, Texas.
Hersell Linton, State College, New Mexico.
Clay Lyle, State College, Mississippi.
Fred W. Mally, San Antonio, Texas.
Geo. M. Marshall, Belvidere, Illinois.
A. A. Mathewson, San Antonio, Texas.
R. E. McDonald, San Antonio, Texas.
R. L. McGarr, Port Lavaca, Texas.
E. R. McGovran, Valdosta, Georgia.
T. McGregor, College Station, Texas.
Walter T. McKay, San Antonio, Texas.
W. H. Mecom, College Station, Texas.
John Medler, State College, New Mexico.
Roy Melvin, Dallas, Texas.
Arthur A. Miller, College Station, Texas.
L. W. Noble, Presidio, Texas.
H. E. Parish, Menard, Texas.
O. W. Park, Ames, Iowa.
H. B. Parks, San Antonio, Texas.
D. C. Parman, Uvalde, Texas.
P. D. Peterson, New York, N. Y.
K. D. Quarterman, San Antonio, Texas.
C. K. Quin, San Antonio, Texas.
H. T. Rainwater, Stillwater, Oklahoma.
H. J. Reinhard, College Station, Texas.
R. R. Reppert, College Station, Texas.
R. C. Roark, Washington, D. C.
J. N. Roney, Dickinson, Texas.
C. S. Rude, Tlahualilo, Durango, Mexico.
I. B. Rutledge, San Antonio, Texas.
P. H. Rylander, San Antonio, Texas.
A. L. Scales, Tallulah, La.
H. M. Scarborough, San Antonio, Texas.
Cameron Siddall, Freeport, Texas.
J. G. N. Singleton, Brownsville, Texas.
Chas. E. Smith, Baton Rouge, La.
Oliver I. Snapp, Fort Valley, Georgia.
W. J. Spicer, Harlingen, Texas.
C. F. Stiles, Stillwater, Oklahoma.
Chas. L. Stracener, Baton Rouge, La.
R. W. Strandtmann, College Station, Texas.
Lee A. Strong, Washington, D. C.
Adolph Thomae, San Benito, Texas.
F. L. Thomas, College Station, Texas.
R. A. Vickery, San Antonio, Texas.
J. G. Watts, Clemson, S. C.
H. E. Welker, San Antonio, Texas.
R. W. White, San Antonio, Texas.
W. H. White, Washington, D. C.
Jack Williams, San Marcos, Texas.
E. D. Wingfield, Houston, Texas.
M. S. Yeomans, Atlanta, Georgia.
H. C. Young, State College, Miss.

The report of the Secretary-Treasurer was then read and approved subject to the audit of the auditing committee.

REPORT OF THE TREASURER

Balance on hand February 1, 1936		$210.92
Receipts		
Refund from parent Association for postage and printing during year ending Jan. 31, 1936	$20.87	
1932 annual dues from 1 member	1.00	
1934 annual dues from 1 member	1.00	
1935 annual dues from 4 members	4.00	
1936 annual dues from 6 members	6.00	
1937 annual dues from 8 members	8.00	
Interest on deposit in Savings Department of First National Bank, Atlanta, Ga.	1.64	
Total receipts	$42.51	$253.43
Disbursements		
Expense for annual meeting in Jackson, Miss. (By action of Executive Committee)	$34.63	
Stamped envelopes and stamps	14.25	
Printing announcements of annual meeting	3.25	
Telegram	.76	
Total disbursements		52.89
Balance on hand February 16, 1937		$200.54

OLIVER I. SNAPP, *Sec'y.-Treas.*

REPORT OF THE SECRETARY

The number of members in the Cotton States Branch on December 31, 1936, was 174, after removing the names of those who moved out of the Branch territory or were dropped by the parent Association for nonpayment of dues. This is exactly the same number that was on the roll at the close of 1935, which is gratifying since there was a gradual decrease in the membership between 1930 and 1935.

The number of members by states on December 31, 1936, was as follows: Texas, 46, Mississippi 25, Louisiana 23, Florida 22, South Carolina 14, Georgia 11, North Carolina 10, Tennessee 8, Alabama 6, Arkansas 5, and Oklahoma 4. The following states showed net increases during the year: Texas 7, Florida 5, South Carolina 2, and Oklahoma 1. Net decreases during the year were as follows: Georgia 4, Louisiana 3, Mississippi 3, North Carolina 2, Alabama 1, Arkansas 1, and Tennessee 1. There are several hundred entomological workers in the 11 Cotton States who are not members of the American Association of Economic Entomologists, and members of the Branch are requested to urge these men to file application for membership in the parent association. Lists of these workers will be glady furnished upon application to the Secretary of the Cotton States Branch.

On January 8, 1937, the Secretary sent to each member of the Branch an invitation to participate in the regular annual meeting in San Antonio, Tex., on February 18–20, 1937. The program for that meeting was mailed on February 15. The proceedings of the eleventh annual (Jackson, Miss.) meeting of the Cotton States Branch were published in the October, 1936, issue of the JOURNAL OF ECONOMIC ENTOMOLOGY [29(5)], and a report on the tenth annual (Atlanta, Ga.) meeting was published in the February 1936 issue of the JOURNAL [29(1)].

Annual dues in the Cotton States Branch are $1. Twenty-two of the 174 members have paid dues for 1936, and only eight members have paid their 1937 dues, which are now payable.

OLIVER I. SNAPP, *Sec'y-Treas.*

Chairman Anderson appointed the following committees: *resolutions*—Clay Lyle, C. H. Alden, F. L. Thomas, C. O. Eddy and F. A. Fenton; *auditing*—R. P. Colmer, C. L. Stracener and H. J. Reinhard; *nominations*—M. S. Yeomans, S. W. Bilsing and R. W. Harned; *publications*—Oliver Snapp and Roy Melvin.

FINAL BUSINESS SESSION

Chairman Anderson called for the report of Committees.

The following resolutions were duly adopted after reading of the report of the Committee on Resolutions, and the Secretary sent them to the parties concerned.

REPORT OF THE RESOLUTIONS COMMITTEE

WHEREAS, The Cotton States Branch of the American Association of Economic Entomologists and the Texas Entomological Society in joint session at San Antonio have had a most successful and highly satisfactory meeting, and

WHEREAS, It is recognized that the spacious rooms and other desirable facilities provided for the meetings have contributed largely to the success of this joint conference, therefore, be it

RESOLVED, That the Secretary of the Cotton States Branch express to F. W. Mally and other members of the committee on local arrangements the deep appreciation of both organizations for the careful attention to details in making all necessary advance arrangements and in looking after the comfort of the members during the meetings. Be it further

RESOLVED, That the Secretary be requested to express the appreciation of both organizations to the management of the Hotel Plaza for the cooperation and splendid service provided.

WHEREAS, The presence of the President of the American Association of Economic Entomologists, Dr. F. C. Bishopp, who attended our paper-reading session, has added much to the success and interest in our meetings, therefore, be it

RESOLVED, That the Branch appreciates the courtesy of this visit and wishes to extend an invitation to the President of the parent Association to attend our meetings annually.

WHEREAS, It has been shown during the joint meeting of the Cotton States Branch of the American Association of Economic Entomologists and the Texas Entomological Society that some of the so-called standard insecticides, e.g., calcium arsenate, vary to such an extent in important properties as to affect the reliability of experimental results, therefore, be it

RESOLVED, That the Bureau of Entomology and Plant Quarantine be requested to make available to research workers a confidential report on the chemical and physical properties of commercial insecticides which may be used in insect control investigations so as to standardize results and recommendations, and that a copy of the resolution be sent to the Chief of the Bureau of Entomology and Plant Quarantine.

WHEREAS, It is recognized that the screw worm is a very serious pest to the live stock industry of the United States, therefore be it

RESOLVED, That the Cotton States Branch of the American Association of Economic Entomologists and the Texas Entomological Society commend the achievements of the research and educational control programs of the Bureau of Entomology and Plant Quarantine and request that Congress provide funds for the continuation of these programs in such areas of the United States as is deemed advisable by the Chief of the Bureau of Entomology and Plant Quarantine.

WHEREAS, The members of the Cotton States Branch of the American Association of Economic Entomologists and the Texas Entomological Society realize that the work of the Division of Cotton Insect Investigations of the Bureau of Entomology and Plant Quarantine has been of inestimable value to the agriculture of the South, and

WHEREAS, Many additional problems have arisen recently which cannot be investigated due to the inadequacy of present funds, therefore, be it

RESOLVED, That Congress be requested to provide additional funds for the Division of Cotton Insect Investigations for the purpose of initiating needed research. Be it further

RESOLVED, That the Secretary of the Cotton States Branch be instructed to forward immediately copies of these resolutions to Henry A. Wallace, Secretary of Agriculture, to Lee A. Strong, Chief of the Bureau of Entomology and Plant Quarantine, and to the Chairmen of the House Appropriations and Senate Finance Committees, and to the Chairmen of the subcommittees of both House and Senate Committee in Congress handling agricultural appropriations.

REPORT OF THE AUDITING COMMITTEE

The Auditing Committee reported that the books and accounts of the Branch had been carefully audited, and found to be correct. This report was then adopted by motion and vote and a certificate given to the Secretary-Treasurer.

REPORT OF THE PUBLICATIONS COMMITTEE

The Publications Committee requested authors to send their papers direct to the editor of the Journal of Economic Entomology for publication in cases where they could not reach the Secretary within a week after the close of the annual meeting.

OFFICERS—1937

The Nominations Committee recommended the following names for officers during the ensuing year: Chairman, W. E. Dove, San Antonio, Tex.; Vice Chairman, C. O Eddy, Baton Rouge, La.; Secretary-Treasurer (3-year term), Oliver Snapp, Fort Valley, Ga. By motion and vote a single ballot was cast for the unanimous election of these officers, and past-chairman S. W. Bilsing escorted Dr. Dove to the chair where he was duly installed as chairman of the Cotton States Branch.

MEETING PLACE—1938

According to the order of meeting adopted last year by the Branch the 1938 meeting must be held in a city on the Mississippi river. By motion and vote New Orleans, La., was designated as the place for the next annual meeting and the executive committee was authorized to select the dates.